U.S. CONSUMER PRODUCT SAFETY COMMISSION

ESTIMATING THE COST TO SOCIETY OF CONSUMER PRODUCT INJURIES:
The Revised Injury Cost Model

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1. INTRODUCTION

The U.S. Consumer Product Safety Commission (CPSC) performs a vital health and safety function. A regulatory agency, CPSC protects the public from unreasonable risk of injury and death from most consumer products. Its mission is to keep families safe in and around their homes.

Annually, incidents under CPSC jurisdiction kill 21,000 Americans and injure almost 30 million. They account for roughly 15% of injury deaths and half of medically attended nonfatal injuries (CPSC 1996).

In the late 1970s, CPSC developed an injury cost model to estimate the cost of consumer product injuries to society. The estimates represented the maximum potential benefits of reducing acute nonfatal injuries. The model did not value deaths, acute illnesses, chronic illnesses, or property damage. Frequency estimates came from CPSC's National Electronic Injury Surveillance System (NEISS).

CPSC's NEISS is the nation's principal source of data about injuries related to consumer products. NEISS monitors and provides statistically valid national estimates of the number and nature of nonfatal injuries treated in hospital emergency departments (EDs). In early 1997, the system used surveillance data from 101 hospitals. Properly weighted, these data accurately represent the 12–13 million consumer product injury victims treated in EDs each year.

CPSC uses estimates of injury costs to analyze a broad range of Commission activities and to communicate to Congress, the public, the media, and others about the potential benefits of CPSC actions.

In 1996, CPSC contracted with the National Public Services Research Institute (NPSRI) for a comprehensive update and revision of the injury cost model. This report documents NPSRI's revised Injury Cost Model (hereafter "ICM"). It discusses the conceptual underpinnings of ICM and documents the methods and data sources used to revise the model. It is organized into 11 chapters. The remaining chapters describe:

2. The original injury cost model. Summarizes the model, changes in the model over time, and model limitations.

3. An overview of the ICM. Explains model theory and concepts. Summarizes the model and describes how it updates and improves on the original model.

4. The data bases used in the ICM. Describes their sources, contents, and limitations.

5. Incidence estimation. Explains how the ICM estimates the number of injury survivors not treated in EDs.

6. Medical cost estimation. Describes how the ICM estimates medical costs for injury victims by highest level where treated (hospital-admitted, treated in the ED but not admitted, other non-admitted medical treatment only).

7. Work loss estimation. Explains how work losses of victims and their families, friends, and employers were estimated. Values lost wage work, household work, and school.

8. Pain, suffering, and lost quality of life estimation and valuation. Derives values for these important, yet hard-to-measure, intangibles. Validates the primary estimates against independent estimates from an alternate valuation method.

9. Product liability insurance and litigation cost estimation. Describes how these compensation-oriented costs are estimated.

10. Mapping into NEISS diagnosis codes. Explains how costs that were developed from data in other diagnosis coding systems were translated into the NEISS coding system.

11. Conclusion. Summarizes the limitations of the revised model and suggests an agenda for future research.

2. ORIGINAL INJURY COST MODEL

This chapter describes the original injury cost model and its upgrading prior to 1996. Several methodological factors strongly influenced the model's design. These included the importance of the concept of social cost in deriving estimates of injury costs, the need for a disaggregated or modular approach to estimating the separate components of injury costs, and the necessity of formulating the functional relationships in terms of the NEISS-contained variables.

The initial specification, estimation, and implementation of the model consisted of three discrete steps. First, at a conceptual level, the elements comprising injury costs were identified and a methodology for estimating those elements specified. Ultimately, 11 separate injury cost components were identified with their sum constituting total injury costs. Second, the data necessary to estimate these components were collected. The three major data sources were the Civilian Health and Medical Program for the Uniformed Services (CHAMPUS) medical claims database, information regarding injury-associated work loss and restricted activity days from the National Health Interview Survey (NHIS), and a sample of jury awards for pain and suffering. Estimation techniques included regression analysis, direct analytic solutions,[1] and utilization of sample means from the disaggregation of large databases. The final step in model development was to program the injury cost algorithms to operate on the NEISS data.

The model contains disaggregated injury cost estimates that can be used with NEISS data to estimate injury costs along the various dimensions of the NEISS sample. These dimensions include diagnosis (a description of the nature of injury and body part injured), victim age and sex, type of product involved, and through supplemental investigation, injury cause.

Methodology

Originally, the injury cost model was composed of eleven separate cost components, which represented three broad types of injury costs: direct expenditures, indirect costs, and intangibles. The seven direct expenditure components included hospital costs, retreatment costs, health insurance costs, product liability insurance costs, litigation costs, victim transportation costs, and visitor transportation costs. Three other components -- victim forgone earnings, visitor costs, and disability costs -- represented the opportunity costs of time spent away from normal activity as a result of the injury. These costs sometimes are collectively termed work losses or indirect costs. Finally, the pain and suffering component places a dollar value on intangible losses. Brief descriptions of the eleven components follow.

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[1] Analytic solutions are estimates derived from assumed relationships between data, as opposed to strictly empirical estimates.

Hospital Costs and Retreatment Costs. Hospital costs involve all medical and hospital expenditures for treatment of the victim of a consumer product-related injury. These expenditures include the costs of medical personnel, facilities, and other health resources required to treat the victim during the basic recovery period. Similar to hospital costs are retreatment expenditures associated with the long-run medical care of the victim. These retreatment costs, incurred after the basic recovery period, include expenditures for corrective surgery, treatment of chronic injuries, and so forth.

Health Insurance Costs. Since health insurance provides protection against medical costs incurred as the result of consumer product-related injuries, the costs of providing the insurance and settling claims must be included in estimates of the societal costs of these types of injuries. The component excludes claims paid to avoid double counting. Health insurance costs include overhead costs such as statistical services, marketing, and public relations, as well as the adjustment costs of handling claims. The model estimates health insurance costs for a given injury type as a fixed component (to account for the average overhead costs of insurance provision) and a variable component, proportional to the associated hospital and medical costs (to account for the influence of the size of the claim on the resultant insurance cost).

Product Liability Insurance Costs. Product liability insurance protects manufacturers and retail establishments against injury cost damages sought by victims of consumer product-related incidents. As in health insurance, the relevant costs are those associated with providing the insurance and settling the claims rather than total premiums paid, again to avoid double counting. On the basis of insurance data and prior studies in this area, estimates were obtained for a fixed overhead component and a variable component proportional to the total costs of the injury. Since not all injuries result in claims, estimates of the probability of filing a claim were developed in order to estimate the expected or average liability insurance costs for any given injury.

Litigation Costs. Litigation costs reflect the legal expenses incurred by injured parties where compensation is sought as the result of alleged negligence in consumer product-related incidents.

Victim Transportation Costs. The transportation cost component involves those expenditures associated with transporting persons injured in consumer product-related incidents to and from medical facilities.

Victim Forgone Earnings. Forgone earnings reflect the value of the time lost from an individual's normal activities as the result of an injury. The associated injury cost component consists of two groups of multiplicative elements: (1) the number of bed days, work loss days, school loss days, and other restricted activity days; and (2) the opportunity cost per day for each of these categories.

Visitor Costs. Visitor costs consist of (1) transportation expenditures incurred by friends and relatives making visits during the victim's recovery period, and (2) the opportunity cost of the time spent transporting the victim to a medical facility or visiting the victim.

Disability Costs. Disability costs reflect the imputed value for work forgone by the injured party permanently or for an extended period and the replacement training costs borne by business.

Pain and Suffering Costs. Pain and suffering refers to the physical and emotional trauma and mental anguish associated with an injury. Pain and suffering costs assign an imputed monetized value for short-term and long-run effects endured by the injured party.

Development

Technology + Economics, Inc. (T+E) developed the original injury cost model in 1975–1976. Between 1978 and 1980 T+E refined the model as part of a subcontract to Battelle Columbus Laboratories. In 1986–1992, the Commission revised its estimation procedures for the pain and suffering component of the model using a more recent set of jury verdicts and different regression techniques.

In 1989–1991, CPSC began preparing for a major revision of the model through two purchase orders to the Urban Institute. That work derived estimated probabilities of permanent work-related disability by NEISS diagnosis and hospital admission status. It also provided diagnosis-specific physician ratings of the functional capacity typically lost to injury and translated these losses into quality-adjusted life years (QALYs) lost. This measure, which is described further in Chapters 3 and 8, was designed as an alternative measure of pain, suffering, and quality of life lost to injury.

3. THE INJURY COST MODEL: CONCEPTS AND ANALYTICAL METHODS

The original injury cost model largely relies on cost and utilization data from the 1970s. Although model estimates are adjusted for inflation, they do not fully account for major changes in medical technology and health care delivery. Notably, they precede the advent of Diagnosis Resource Groups (DRGs) as a basis for hospital payment, the Medicare Prospective Payment System, managed health care, Magnetic Resonance Imaging (MRIs), even Computerized Axial Tomography (CAT scans).

The revised ICM replaces the 1970s data with data from the 1990s. In the 17 years since the original ICM was completed, increasing computer capability has stimulated the growth of new, far more extensive data sets to support injury cost modeling. Consequently, the revised model uses different data sets than the original model, often replacing analytic solutions with data-driven estimates. An example of an analytic solution in the original model is the retreatment cost component; retreatment costs for non-surgical cases were assumed to equal one-half of initial treatment costs. In the revised model, retreatment costs for victims not admitted to the hospital are estimated from diagnosis-specific data.

Thus, the revised model replaces many of the assumptions used to estimate costs in the original model with cost estimates developed by analysis of actual data. The computations underlying the revised model also explicitly cost items that the original model did not estimate. The original model, for example, assumed that medical equipment and supplies were included in the retreatment cost component.

No data set, however, contains all the necessary cost factors. The modelling effort combined information by diagnosis from NEISS and 17 other large data sets. Frequently, several years of data were pooled to get enough cases for a diagnosis-specific analysis. The revised model derives costs by age group, sex, and hospital admission status for hundreds of injury diagnoses. Yet this detailed breakdown is essential to accurate costing. Someone age 25, for example, faces different losses from a broken leg than someone age 80.

Unlike the original model, the revised ICM uses NEISS data to estimate the number and nature of nonfatal injuries that only were medically treated outside of an emergency department. The system also costs these injuries. The incidence estimates are built from diagnosis-specific ratios of non-ED cases to ED cases in National Center for Health Statistics data sets and in a family of Missouri health care discharge data sets.

Cost Components

Although the original model consisted of 11 cost components, the detailed cost breakdown proved unbalanced. Several components each detailed less than 1% of an injury's cost. The costs almost always were grouped for reporting purposes. For example, hospital and retreatment costs were summed to obtain health care costs. Experience suggests grouping the 11 cost components into more aggregated categories for reporting. Reports generated by the revised ICM only show four distinct cost components:

- Medical costs
- Work losses
- Quality of life and pain and suffering costs
- Product liability insurance administration and litigation costs

The content of these cost components is as follows.

Medical Costs. This component includes the original hospital and retreatment cost components, plus ambulance transport and health insurance claims processing. It includes costs of emergency medical treatment and ambulance transport (including air ambulances); hospital, physician, and rehabilitation costs including post-discharge costs for hospital admitted cases; and ancillary costs for prescriptions, medical equipment and supplies, allied health services, home health services, nursing home care, and home health care. Because data are lacking, this component omits costs for trauma-induced mental health treatment of victims and their families.

Work Losses. This component includes the original forgone earnings, visitor forgone earnings, and disability components. It includes the value of (1) victims' lost wage work and household work, as well as fringe benefits, (2) any lost schoolwork, and (3) the work family and friends lose while caring for, transporting, and visiting the injured. Finally, this component includes employer productivity losses, most notably the costs when supervisors spend time juggling schedules or recruiting and training replacements for injured workers.

Quality of Life and Pain and Suffering Costs. Conceptually, this component is unchanged from the original model. It places a dollar value on the intangible losses that result from an injury. These include pain, suffering, and lost quality of life.

Product Liability Insurance and Litigation Costs. This component includes the original product liability insurance administration and litigation cost components. It includes the administrative costs of compensating product liability insurance claims related to injury, as well as attorney fees; court costs; plaintiff, defendant, and witness time; and out-of-pocket expenses (e.g., for transportation) that arise in litigation related to liability and compensation.

The ICM estimates costs from society's viewpoint. That means ICM estimates the aggregate costs, regardless of who pays them. Societal costs are broader than costs to any individual group, such as victims, insurers, or product manufacturers. The costs adhere to the guidelines for estimating cost of illness in Gold et al. (1996) and Hodgson and Meiners (1979, 1982). These guidelines establish an accounting framework and the conceptual basis for valuing lost work. They also are consistent with Miller, Calhoun, and Arthur (1989), which derives a theory-based accounting framework for injury and illness costs that include estimates of pain, suffering and lost quality of life.

The theory, the cost framework, the costing concepts, and the methods for the ICM are widely accepted in the peer-reviewed literature. They have been used to cost highway crashes (Miller 1993), drunk-driving crashes (Miller and Blincoe 1994), railroad crashes (Miller, Douglass, and Pindus 1994), bicycle injuries (Miller et al. 1994), occupational injuries (Miller and Galbraith 1995), criminal victimization (Cohen 1986, Miller, Cohen and Rossman 1993, Miller, Cohen and Wiersema 1996), cigarette fire injuries (Miller et al. 1993), poisonings (Miller and Lestina 1997), injuries by diagnosis (Miller, Pindus, Douglass and Rossman 1995), injuries by age group and sex (Rice, MacKenzie and Associates 1989), drug abuse (French et al. 1996), and alcohol abuse (Manning et al. 1989, 1991). They are used in regulatory analysis throughout the US Department of Transportation (McCormick and Shane 1993).

Discount Rate

The costs presented are incidence-based. That means all costs of an injury over the victim's lifespan are included. Whenever costs extend more than a year beyond the injury, the ICM applies a discount rate to compute their present value. Because discounting applies to many cost factors, the choice of a discount rate is a cross-cutting decision that helps to shape the estimates for each cost component.

A 2.5% real discount rate was used. The 2.5% rate is toward the **upper end** of the 1% to 3% range that the US Supreme Court (1983) ruled is appropriate for computing personal injury liability compensation. It also is consistent with the 3% discount rate recommended by Gold et al. (1996).

An upper end choice is conservative. Higher discount rates yield lower estimated lifetime costs.

Following Gold et al.'s (1996) guidance, the same discount rate was applied to future QALY losses associated with permanent disability as to future medical and work-related costs. Discounting of future life years correctly models health decision-making described in general population surveys and revealed by safety behavior (see, e.g., Cropper et al. 1992, Moore and Viscusi 1990, Olsen 1993).

Summary of Methods

All ICM cost estimates are diagnosis specific (meaning they vary by body part injured and nature of injury diagnosis). The estimates vary by age and sex. Medical costs, quality of life and pain and suffering costs, and product liability insurance administration and litigation costs also vary depending on the highest level (also called the setting) where medical treatment was received. The treatment level hierarchy is (1) hospital-admitted, (2) treated in the hospital emergency department (ED) and released but never hospital-admitted, or (3) treated only in non-hospital settings such as a doctor's office or walk-in clinic. Non-admitted cases treated in ambulatory surgery centers are assumed to have comparable costs to non-admitted ED cases. Because of data limitations, work losses are differentiated only between hospital-admitted and medically treated non-admitted cases.

The next four sections provide an overview of how the various cost estimates included in the four cost components of ICM were computed. Chapter 4 provides details about the data sources used. Subsequent chapters provide details about the cost estimates and costing methods.

Medical Costs

Medical costs were estimated by diagnosis and level of medical treatment. This summary describes cost estimation methods for non-admitted injury survivors, including those treated in emergency departments and in doctor's offices, for hospital-admitted injury survivors, and for health insurance claims processing costs for all medically treated injury survivors.

As in the original model, CHAMPUS provided medical payments per non-admitted injury victim with two exceptions. (1) CHAMPUS omits the costs of prescriptions and non-physician care. These costs came from the National Medical Expenditure Survey (NMES). The original model did not correct for this omission in the CHAMPUS data. (2) Unlike the original model, the CHAMPUS data available for the ICM only described spending in roughly the first six months after injury. Pindus et al. (1990) provided a multiplier to estimate lifetime costs from the short-term costs. The multiplier came from an analysis of longitudinal data on medical costs of workplace injuries. NMES and National Health Interview Survey (NHIS) data were used to differentiate the costs of non-admitted injury victims treated in emergency departments from victims treated only in doctors' offices or clinics.

For hospital-admitted injury, medical care costs have two major components. The first is inpatient cost, computed as length of stay multiplied by hospital cost per day including professional fees. The second includes ambulance, ancillary, and post-discharge costs such as prescriptions, canes, and follow-up medical care. Length of stay by diagnosis came from National Hospital Discharge Survey (NHDS) data. These data, however, do not differentiate consumer product injuries. Data from five cause-coded statewide hospital discharge censuses were used to adjust length of stay to account for the impacts of consumer-product origin, victim age, and victim sex. Consumer product injury victims generally have significantly different -- and, in aggregate, lower -- lengths of hospital stay than other victims with comparable primary diagnoses. The differences probably reflect differential injury forces and frequencies of injury to multiple body regions. For example, a leg fractured in a fall off a step is broken with less force than one shattered in a highway crash, and the victim is less likely also to need treatment for facial wounds inflicted by flying glass.

Costs per hospital day also are specific to consumer product injury. They came from New York and Maryland, the only states where cost-control commissions require hospitals to report publicly and accurately their costs by patient. The discharge abstracts in these states indicate injury diagnoses and causes. The costs were price-adjusted from state to national estimates with American Hospital Association data on mean hospital costs per day by state. Professional fees were estimated with a ratio of professional fees to hospital payments computed from CHAMPUS data. Diagnosis-specific regression models then were developed that separated the costs of consumer-product injuries into a fixed cost per admission and a variable cost per day (which was multiplied by the adjusted NHDS length of stay in computing costs per case).

Ambulance, ancillary, and post-discharge costs during acute care came from NMES. These factors were computed as percentages of hospital costs. Pindus et al. (1990) provided short-term to lifetime medical care cost multipliers.

The cost algorithm for hospital-admitted patients improves on the original model primarily in four ways: (1) it uses hospital costs specific to consumer product injury, (2) it captures ancillary costs, (3) it replaces analytic estimates of long-term (retreatment) costs with direct measures from Pindus et al. (1990), and (4) it rests more firmly on nationally representative data sources.

Health insurance claims processing costs as a percentage of claims costs came from insurance statistics.[2] The percentages vary by payer. To compute an overall percentage, they were weighted with the distribution of payers for consumer product injuries by highest level of medical treatment (hospital-admitted, treated at the ED and released, or other non-admitted treatment only).

Lost Work

Work loss includes losses by victims, family, friends, and employers. ICM cost estimation differentiated victim losses between short-term work loss and long-term loss due to permanent work-related disability. Short-term work loss is the loss resulting from the victim's physical inability to work while recovering from an injury. Long-term work loss is the loss associated with permanent disability that remains after the injury victim has recovered to the maximum extent possible.

[2] A large number of data sources were used in estimating health insurance claims processing costs, as detailed in Chapter 6.

Short-Term Work Loss. Short-term victim work loss consists of two groups of multiplicative factors: (1) the number of lost days of wage work, household work, or school work, as well as the number of other restricted activity days; and (2) the loss per day for each of these categories. All computations were done by injury diagnosis.

Detailed information is available about short-term work loss days. By diagnosis, the number of days an injury survivor loses in the short term was computed from NHIS data on the probability that a worker will lose work when injured and Bureau of Labor Statistics (BLS) data on the average days lost per lost-work injury.

Lost household work days were estimated from the work loss information and data showing that workers suffering only from short-term disability return to household work 10% faster than wage work. The NHIS and BLS data guided development of analytic estimates for the other categories. A key assumption underlying the estimates is that a given injury costs the victim the same number of days of ability to work, whether or not the victim is employed.

Days of lost ability to work were valued with the method recommended by the Panel on Cost-Effectiveness in Health and Medicine (Gold et al. 1996) and by Hodgson and Meiners (1979, 1982). They suggest valuing a day of lost work from published national statistics about the wage and fringe benefit loss per day of wage work by age and sex. Household work hours per day by age and sex were estimated with published regression equations that are widely accepted for this purpose (Peskin 1984). Published data also describe the distribution of household work hours among tasks (e.g., cooking, yard work). National wage data by occupation were used to value these hours.

Long-Term Work Loss. Permanent work-related disability probabilities came from a large national sample of worker injuries.[3] The percentage of lifetime work lost to permanent disability came from this same source, supplemented by information from a major study by Berkowitz and Burton (1987).

Permanent disability is valued as a percentage of the present value of expected lifetime work. Lifetime work is valued by summing the discounted present value of expected earnings (wage and fringe benefit compensation plus the value of household work) by age and sex, absent the injury, across the victim's remaining lifespan. In the ICM, this computation averages labor force participation rates over 20 years to account for employment prospects across the business cycle in the estimates.

ICM improves on the original disability component by replacing analytic estimates of permanent disability costs with the data-driven estimates described above and by introducing 20-year-average values into the lifetime earnings calculation.

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[3] Pindus et al. (1991) estimated the probabilities used in ICM.

Employer Losses. Employer losses due to injury were estimated analytically from supervisor and worker wage data in combination with assumptions about the amount of non-productive time resulting from an injury. These costs were not analyzed explicitly in the original model; they were subsumed in the disability component.

Quality of Life and Pain and Suffering Costs

Pain, suffering, and lost quality of life typically is the largest contributor to injury costs. Because these intangibles cannot be purchased, they also are the most difficult to value. Recognizing their importance and computational challenge, ICM offers a monetary estimate of the intangible losses computed from the pain and suffering component of jury awards, plus optional sensitivity analysis that provides non-monetary estimates of quality-adjusted life years when estimates are available.

The monetary value estimates for pain and suffering come from regression analysis of 1,986 jury awards and settlements to victims of non-fatal injuries involving consumer products. The cases were sampled from a proprietary national data set[4]. They include product liability cases, cases involving bicyclists injured by motor vehicles, and premises liability cases that involved consumer products (e.g., a leg broken in falling down the stairs or tripping over a toy that a child dropped on the sidewalk). Class action suits were excluded from the analysis.

The alternative QALY-driven method used in the sensitivity analysis starts with diagnosis-specific physician ratings of the functional capacity typically lost to injury. The ratings describe losses on bending/grasping/lifting, cognitive, mobility, sensory, cosmetic, and pain scales. Using survey data describing how people value the six scaled dimensions of functioning, the functional losses are translated into quality-adjusted life years (QALYs) lost.[5]

The primary improvement in pain and suffering estimates over earlier versions results from the substantial increase in the number of jury awards available for analysis. The revised model also produces credible QALY information. QALYs measure quality of life losses without placing a dollar value on fatal risk reduction, dollar values which many health policy analysts feel vary too widely to be credible. QALYs are the preferred loss measure in the medical literature (Gold et al. 1996) and in many Federal agencies. They are widely used in cost-effectiveness and cost-utility analysis.

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[4] A proprietary data set contains copyrighted data that can only be accessed upon completion of a licensing agreement as opposed to government data that typically are readily accessible, provided they are free of individual identifiers.

[5] These estimates use the approach to cost outcome analysis recommended by Gold et al. (1996). Both the National Highway Traffic Safety Administration and the Department of Health and Human Services use QALYs extensively in cost outcome analyses.

Product Liability Costs

Product liability costs include two components: insurance and legal. The *product liability insurance* component reflects costs associated with defending the insured manufacturer or seller, the costs of claims investigation and payment, and general underwriting and administrative expenses. It excludes insurance sales costs. No single product or type of injury dominates the consumer product injury picture. Consequently, although sales costs certainly are part of the aggregate costs of consumer product injury, they are essentially fixed costs, not marginal costs that decline when injuries are averted. Estimates of insurance costs are derived from aggregated insurance industry data.

As in the original model, *legal costs* include court and claiming expenses, plaintiff attorney fees, and time spent by plaintiffs, defendants, and witnesses. Estimates are based on survey research data on the probability of reaching different stages of litigation (e.g., filing a lawsuit, trial) and the variable costs at each stage of litigation.

4. DATA SETS USED AND THEIR CONSISTENCY

This chapter describes the 18 principal data sets that provide incidence and cost data to ICM. Some of these data sets are primary sources of incidence or cost data. Many provide just one or two narrow data elements needed for a calculation.

This chapter describes each data set's source, size, contents, and limitations. Then it probes the consistency of data sets with overlapping information. The comparisons make it clear that the data sets are compatible; information from them credibly can be combined.

Before describing the data sets, this chapter briefly discusses how they code injuries and how injury coding affected the analysis. Chapters 6 and 10 further discuss injury diagnosis coding.

Injury Diagnosis and Cause Coding

This report defines an **injury diagnosis** as the combination of a body part designator (e.g., foot) and a nature of injury diagnosis (e.g., fracture). Three of the 18 data sets analyzed, including NEISS, use two separate codes to describe the body part injured and the nature of injury diagnosis. Most medical data sets instead use International Classification of Diseases, 9th Edition (ICD-9) diagnosis codes which describe body part injured and nature of injury with a single code.

Many tables in this report present data by diagnosis group. Because diagnosis coding differed between data sets and diagnoses had to be grouped so that the sample size in each group would be large enough to yield stable estimates[6], the grouped diagnosis categories differ between tables. Since different chapters of the report rely on different data sets, the differences in categories are especially great between chapters.

In addition to diagnosis codes, ICD-9 includes optional external-cause-of-injury codes (E-codes or cause codes). These codes may designate either the place where the victim was injured or the cause of the injury. Some states mandate ICD-9 cause coding for hospital-admitted or hospital-treated injury victims. Because it sometimes is ambiguous whether an ICD-9 diagnosis code describes an injury (for example, is dermatitis simply dry skin or an injury inflicted by a caustic chemical?), cause-coded state data sets identify injury victims more clearly than other data sets. Although ICD-9 cause codes do not explicitly differentiate injuries related to consumer products, they do identify some injuries (e.g., intentional injuries, environmental injuries like frostbite or snake bite, and transportation injuries) that clearly are not under CPSC jurisdiction. When analyzing cause-coded data sets, we generally restricted our analysis to victims whose injuries might relate to consumer products.

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[6] Estimates without excessive standard errors.

Data Sets Analyzed

ICM draws data primarily from 10 national data sets and 8 state data sets. The national data sets are sample surveys. They are designed primarily for surveillance. Many are conducted annually. For annual surveys, we generally pooled several years of data to obtain larger sample sizes by diagnosis group.

Two of the state data sets are censuses of Missouri discharges from emergency departments and ambulatory surgery centers. The remaining six state data sets contain hospital discharge data. These six states are among the roughly 30 states that maintain computerized hospital discharge abstract censuses. Often these data sets are compiled by state hospital associations. Participation in some is mandated by state health departments or cost-control commissions. Others are voluntary systems with universal compliance.

These censuses have multiple purposes. Foremost is their role in quality-control review of hospital care. They also are designed for surveillance, inter-facility comparison, and in some states, cost control. Starting in the late 1980s, selected hospital discharge systems began requiring inclusion of external-cause-of-injury codes (E-codes) on acute injury victims' discharge abstracts. By 1996, a dozen states required E-coding and had at least a year of data with compliance levels of 90% or higher. All state data analyzed for ICM are E-coded.

Most of the data sets were used to estimate components of medical costs. Two national data sets -- the National Health Interview Survey (NHIS) and the Detailed Claims Information (DCI) data base of the National Council on Compensation Insurance -- yielded both medical cost and work loss information. Work loss data also came from the annual Bureau of Labor Statistics (BLS) Survey of Occupational Illness and Injury. NHIS and three Missouri data sets provided information on the incidence of injuries not treated at hospitals.

The remainder of this section lists and describes the individual data sets. Table 1 summarizes some of the descriptive information.

This report abbreviates the data set names. This chapter is a reference source for readers who want more information about specific data sets. For the reader's convenience, the data set descriptions are alphabetized by their abbreviated names. The abbreviated names also appear in the glossary.

- BLS Annual Survey. 1993 Annual Survey of Occupational Illness and Injury from the Bureau of Labor Statistics (BLS). This data set is a national probability sample of injured workers. It includes injury victims with an occupational injury incident from each US employer except most governments, agricultural enterprises with less than 11 employees, and self-employed individuals without unrelated employees. For 1993, it described work loss duration for 603,936 lost-work occupational injuries in private industry. The data include BLS injury codes, which are close relatives of NEISS injury codes. The survey only collects days lost during the calendar year. This project built statistical models that inferred the full duration for injuries with long periods of work loss and for injuries that occur near the end of the calendar year. For this project, the major limitations of the BLS Annual Survey are its restriction to occupational injury and working age populations.

- CHAMPUS. 1992–1994 Civilian Health and Medical Program of the Uniformed Services reimbursement summaries (summary tables only, not individual claims). CHAMPUS summarizes medical utilization, reimbursements, and self-pay for roughly 2,000,000 military retirees and civilian dependents of military personnel (but *not* currently active military personnel themselves, who receive free medical care as part of their compensation). It excludes Veteran's Administration hospital treatment and on-base medical care. CHAMPUS is the most representative data source available for current information on physician payments associated with hospital care or on diagnosis-specific payments for visits to physicians and EDs. The summary reports cover 24,150 hospital admissions for injury and 2,256,583 injury episodes treated in non-admitted settings (including follow-up care for victims who were admitted). The reports are by primary diagnosis coded at the 3-digit summary level with ICD-9 codes. Restriction to 3 digits limits the diagnostic detail available; sometimes it does not reveal the body part injured. Data representativeness is reduced because CHAMPUS covers few males ages 18–45 and few people over age 65. With the increase in women in the military, however, CHAMPUS coverage of working-age males (as military spouses) is increasing.

- DCI. 1979–1987 Detailed Claims Information (DCI) data base of the National Council on Compensation Insurance. This longitudinal proprietary file is a nationally representative sample of Workers Compensation lost workday claims (which involve compensation for both medical costs and wage losses). The data come from Workers Compensation insurers in a cluster sample that varies slightly by year of injury but typically covers about 15 states. Pindus et al. (1990, 1991) developed data summaries for 1979–1987. The summaries are based on 452,000 injuries, 138,000 of them hospital-admitted. Insurers report on claims in the DCI sample six months after the injury and annually thereafter until the claim is closed (meaning no more charges are anticipated or a reserve was set aside -- and reported to DCI -- to cover predictable future costs). DCI claims are reopened if unanticipated costs arise after closure. DCI lists a single injury diagnosis. Diagnosis coding is done with a variant of the American National Standards Institute Z-16.2 coding system. This system is similar to the NEISS diagnosis coding system.

  DCI data are the only known source for the percentage of medical payments associated with the first six months of an injury episode (information needed to compute lifetime costs from acute care costs). The DCI record includes all medically related payments including hospital care; professional services; prescriptions, equipment, and long-term care; vocational rehabilitation payments; and length of stay if hospital-admitted. The

DCI also reports if the victim's injury resulted in permanent total or partial work-related disability.

Weaknesses of this data base are its restriction to workplace injury -- about one-third of all injury -- and to working-age populations. The data also are aging.

- JVR. Jury Verdicts Research data. This proprietary data set summarizes more than 100,000 jury awards, settlements, and arbitrations resulting from personal injury and illness claims between 1988 and 1995. It is believed to contain at least 70% coverage of recent jury verdicts in individual suits (but not class action suits) as well as a less representative selection of settlements. The data are indexed by type of claim, making it easy to identify product liability claims and product-related premises liability claims. Most data are in narrative form. We coded the narratives for 1,986 product-related nonfatal injury cases. With narrative input, data like victim age and whether the victim was hospital-admitted unavoidably are missing from a fairly large number of cases. Sometimes even a break down of the amount awarded between compensation for medical and wage losses versus pain and suffering is missing.

- Missouri Discharge Data (3 data sets). 1994 Missouri Ambulatory Surgery Center, ED, and Hospital Discharge Censuses. CPSC was able to obtain discharge files with personal identifiers that could be used to link records across provider types[7] and to analyze readmission rates. Excluding fatal incidents, the data sets describe 627,135 non-admitted injury ED visits, 51,106 injury hospital admissions, and 22,487 injury visits to ambulatory surgery centers. The records include patient demographics, one external cause code, and nine 5-digit ICD-9-Clinical Modification (ICD-9-CM) diagnoses. They contain no financial data. The limitations of these files are their restriction to one state and one year (a problem when examining utilization patterns), as well as the absence of personal identifiers on one-eighth of the non-admitted records. Also, because Missouri requires only one external-cause code for each injury discharge, it is difficult to accurately differentiate injuries related to consumer products.

- NAMCS. 1992–1994 National Ambulatory Medical Care Survey. This annual national probability sample survey of providers is conducted by the National Center for Health Statistics (NCHS). It gathers information about visits to physician offices and clinics. It collects data on about 35,000 visits annually. The 1992–1994 data include 4,800 injury visits. NAMCS records three ICD-9-CM diagnoses, patient age, patient sex, and expected source of payment. NAMCS indicates if a patient was directly admitted to the hospital by the doctor. NAMCS does not clearly distinguish initial

[7] Providers are the sources of medical care, including hospital in-patient departments, hospital emergency departments, doctors' offices, walk-in clinics, and ambulatory surgery centers.

versus follow-up visits. More important, referral to emergency room where treated and released is coded as "other disposition", a category that also contains non-ED cases. Other limitations are the absence of cause codes and incomplete coverage of providers (e.g., company and school health clinics are excluded).

- NEISS. CPSC's National Electronic Injury Surveillance System data base. From an annual sample of 101 hospitals reporting about 340,000 injuries, NEISS makes national estimates of hospital emergency department visits for selected causes. The system records which of these visits result in admission. The ICM is built around NEISS incidence data on consumer product injuries. The NEISS uses a two-column diagnosis coding system (a body part code and a nature of injury code such as fracture or contusion). Only the victim's most serious injury is coded. Because coding is done in the ED, diagnoses are sometimes not as precise as ICD-9 diagnoses. For example, the duration of a coma often is not known when the patient is transferred from the ED to the trauma service or neurological service. When CPSC is analyzing a particular hazard, it often carries out follow-up telephone or on-site interviews of NEISS injury victims or their families. These interviews are called in-depth investigations. Sometimes, questionnaires developed for these investigations ask for more detailed information on the nature of injury than is contained in the NEISS record.

- NHAMCS. 1992–1994 National Hospital Ambulatory Medical Care Survey – Emergency Department Sample (NHAMCS). This annual national probability sample survey of providers was implemented by the NCHS in 1992. It gathers information about visits to hospital emergency and outpatient departments. It collects data about 35,000 ED visits annually. The 1992–1994 data include 36,686 injury visits to EDs. NHAMCS distinguishes initial from follow-up visits, records three ICD-9-CM diagnoses and an E-code for each injury visit, and records discharge status (admitted and dead are key), patient age, patient sex, and expected source of payment.

- NHDS. 1987–1992 National Hospital Discharge Survey. This annual NCHS hospital survey obtains information on roughly 200,000 hospital discharges annually. The 1987–1992 data yielded 111,324 injury discharges and 185,093 discharges for diagnoses that sometimes result from illness and sometimes result from injury (for example, dermatitis or coma). We included all cases where at least one discharge diagnosis was an injury. NHDS describes victim age, sex, up to seven diagnoses by ICD-9-CM code, length of stay, discharge destination (e.g., home, nursing home, morgue, etc.), and expected primary payer. The major limitations of NHDS are its lack of injury cause coding (which makes it impossible to determine which injuries were related to consumer products or even whether some patients were injury victims) and its failure to distinguish initial admissions from readmissions.

- NHIS. 1987–1992 National Health Interview Survey. This NCHS survey annually polls 45,000 households containing about 110,000 people. NHIS records where each medically treated or activity-restricting injury or illness that happened in the two weeks prior to interview was treated. NHIS codes the ICD injury description in ICD-9-CM from the victim's self-reported description, which makes the diagnosis coding imperfect.

Small sample size makes NHIS an unreliable source of data on hospital-admitted injury (Miller, Pindus, et al. 1995). ICM includes NHIS data only from non-admitted cases. Between 1987 and 1992, NHIS recorded 4,476 acute non-admitted injury incidents. NHIS data include victim age, sex, place of occurrence, self-reported diagnosis, highest level of medical treatment, whether the victim was employed, whether the victim lost work, and bed days and other restricted activity days resulting from the injury.

One important NHIS limitation is that information about work loss and restricted activity days is recorded only for the two weeks prior to the interview. No information is provided to differentiate victims whose activities still were restricted at the time of interview. NHIS sample size is a second limitation. Even a 6-year sample is too small to make stable estimates by diagnosis and highest treatment level, which limits the detail available from the survey. A final major limitation is the inaccuracy of self-reported diagnoses. Exacerbating this problem, NHIS rarely reports multiple diagnoses; when it does, it is difficult to link the second diagnosis to the victim.

- NMES. 1987 National Medical Expenditure Survey. NMES was conducted by the Agency for Health Care Policy and Research. The most recent survey of its type, it records or estimates the costs of all visits to medical providers during 1987 by a national probability sample of 14,000 households containing about 35,000 people. NMES gathers data from both households and their medical providers. Diagnoses are coded in ICD-9-CM from provider records. Expenditures for outpatient visits in NMES come from three sources: (1) when charges were only partially paid by third-party payers such as insurers and Medicare, expenditures equal payments including co-pay; (2) when there was no explicit charge for medical services, for example, services provided by governments, charities, or HMOs, NMES imputes a cost from the expenses associated with similar services; and (3) otherwise, expenses are represented by charges.

NMES provides the only known nationally or regionally representative data that describe post-discharge medical, prescription, home health, non-medical therapist, and other ancillary expenses, or costs per ambulance transport. It also describes utilization patterns.

The largest limitation of NMES is its sample size. The data include only 397 admitted injury victims and 5,439 medically treated non-admitted victims. NMES data also are aging. A final limitation is the restriction to medical treatment received in one calendar year, 1987, which reduces NMES' ability to describe utilization patterns. On average, the data describe treatment and medical spending in the first six months after injury. The descriptions, however, cover varying periods after injury. They are spread uniformly from cases tracked only on the day of injury (for injuries on December 31, 1987) to cases tracked for 365 days (for injuries on January 1, 1987).

- Pooled 5-State Hospital Discharge Data. Five state hospital discharge censuses. We pooled and thoroughly cleaned data describing all 586,669 live injury discharges from five states: California in 1993, Maryland in 1994–1995, New York in 1994, Washington in 1989–1991, and Vermont in 1990. Importantly, in addition to the kinds of data NHDS collects, these data sets indicate which discharges were for acute injury. More than 90% of cases with ICD codes 800–995 have external cause codes (a total of 499,101 cases). The E-codes allowed us to differentiate consumer product injuries; we applied the classification criteria CPSC developed in Kessler and Reiff (1995) but included all instead of a percentage of qualifying injuries that occurred in recreation. residential institutions, public buildings, and other specified places. The pooled data include 292,436 live injury discharges potentially related to consumer products. Our algorithm for identifying consumer product injury requires at least two E-code fields; typically, the first E-code describes the primary external cause while another identifies the place of occurrence. Because it has only one E-code field, we excluded Missouri from the pooled data set.

  Like NHDS, pooled state data include length of stay and patient demographics. The Maryland and New York files also contain accurate, current hospital care costs. An obvious limitation of the pooled state data is its lack of national representativeness. A second limitation is the inability to accurately distinguish initial injury visits from readmissions.

Data Consistency and Validity

Many ICM cost estimates were derived by combining data from at least two data sets or using data sets that may not be nationally representative. To be credible, these computations require reasonable consistency between the data sets. Fortunately, although each data set used in the computations offers some unique information, the data sets also typically contain overlapping information. The overlap allows us to probe consistency. This section documents the consistency of demographic, length of hospital stay, and medical cost data in selected study data sets. Some of its evidence comes from past validations of data sets used in the ICM. The validation efforts affirm the credibility and representativeness of ICM data.

Demographics. Because the pooled 5-state hospital discharge data include about five times as many cases, more clearly identify discharges related to injury, describe injury cause, and sometimes include personal identifiers or cost information, we often preferred them over NHDS data. An obvious issue is the representativeness of the pooled state data. As Figure 1 shows, the age and sex distributions in NHDS and the 5-state data are virtually identical.

Length of Hospital Stay. Injury victims in the pooled 5-state hospital discharge data average slightly shorter stays than in national data from NHDS or CHAMPUS. Nevertheless, as Table 2 shows, average length of stay varies widely between the state hospital discharge data sets. New York has much longer stays than the other states (perhaps in response to the state's tight controls on cost per day). California and Maryland have the shortest stays. These patterns hold at the diagnosis level as well as across diagnoses.

NHDS and CHAMPUS have similar average lengths of stay, suggesting that the small number of elderly and of males ages 18–45 covered by CHAMPUS does not cause serious representativeness problems. Length of stay is quite variable, with standard deviations almost double the mean. This variability increases our certainty that the small differences in mean lengths of stay between NHDS, CHAMPUS, and the pooled 5-state data are not meaningful. Their agreement suggests it is credible to combine data on hospital-admitted cases from these sources.

In Table 2, differences in means between years or data sets may result from case mix differences rather than differences in length of stay for comparable diagnoses. For example, when the mean NHDS length of stay is computed by multiplying mean length of stay for each diagnosis by the 1990–1992 case count for that diagnosis, the 1987–1989 and 1990–1992 mean lengths of stay differ by only 0.01 days. As a second example, mean length of injury stay was stable from 1984–1986 to 1990–1992 in NHDS. Computed with the 1984–1986 diagnosis mix, however, average NHDS length of stay dropped from 6.3 days in 1984–1986 to 5.8 days in 1990–1992. It appears that cost-control efforts reduced length of stay for comparable diagnoses, but also reduced admissions for diagnoses with short average stays.

Medical Costs. A prior study (Miller et al. 1995) tested medical cost consistency among some of the data sets used in ICM. Although ICM uses data from more recent years than the prior study, we believe consistency of older data from these data sets yields insight into the credibility of ICM data sources. Where practical, this section also assesses the consistency of the more recent medical cost data used in ICM.

The older comparisons are from Miller et al. (1995), which estimated medical costs by diagnosis and hospital admission status. These cost estimates were validated against costs per case from Rice et al. (1989). Rice et al.'s costs were more clearly nationally representative but were not diagnosis-specific.

For non-admitted cases, Miller et al. (1995) used first year medical payments including co-pay from CHAMPUS, which implicitly included an average of 1.9 medical visits per case. Rice et al. combined NHIS visit counts (which average 2.0 visits per case) with payments per visit inflated from the National Medical Care Utilization and Expenditure Survey data (the 1980 version of NMES). As Table 3 shows, the two data sources yielded virtually identical costs per case (computed with the same diagnosis mix). Their consistency strongly suggests CHAMPUS costs for ED/doctor visits are nationally representative.

For admitted cases, both Miller et al. (1995) and Rice et al. (1989) used NHDS/Maryland data on first-year length of stay. Miller et al. (1995) used total medically related DCI payments per hospital day. This procedure implicitly assumes that other costs were proportional to length of stay. Total DCI payments include hospital per diem, professional fees, nursing home payments, prescriptions, equipment, and attendant care. Rice et al. used hospital costs per day from Maryland; an add-on of 25% for professional fees; payments for prescriptions, other items, and outpatient physician and physical therapy visits from NMCUES; plus data on minor cost factors from various sources. The two estimates of medical costs per injury with hospital admission differ by less than 2% (Table 3). Their similarity suggests it is reasonable to assume both the DCI data and the hospital costs in Maryland hospital discharge data are representative.

Table 4 compares estimated costs per live hospital discharge for injury from Maryland and New York with cost estimates from prior studies. After adjusting for the overall temporal trend in cost per hospital day,[8] estimated costs per injury discharge are relatively stable over time. CHAMPUS costs have fluctuated around the DCI average. Average pooled Maryland and New York costs are within 3% of the DCI average. Costs in New York are slightly above CHAMPUS or DCI costs while Maryland costs are slightly below them. The consistency of costs and lengths of stay in DCI, the state hospital discharge data sets, and CHAMPUS data again means it is credible to mix data from these sources. Their consistency also suggests these sources are reasonably representative of the nation.

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[8] The adjustment used annual American Hospital Association data on average cost per hospital day by state, as published in the US Statistical Abstract (Bureau of the Census annual).

TABLE 1. Summary of Data Sources

Database	Population Covered	Coding Scheme	Number of Cases	Years	Data Elements Used	Comments
BLS Annual Survey of Occupational Illnesses and Injuries (Bureau of Labor Statistics)	Annual sample of lost-workday occupational incidents	Variant of ANSI Z-16.2	603,936 cases	1993	Days lost per injury	Restricted to workers
CHAMPUS Civilian Health and Medical Program of the Uniformed Services (Department of Defense)	Annual summary of claims for about 2,000,000 military dependents and retirees	ICD-9 3 digit level; used codes 800-995 only	2,256,583 injury episodes treated in non-admitted settings 24,150 injury hospital admissions	1992-1994	Ratio of professional fees to hospital payments; payments per non-admitted case	Longitudinal for one year; inpatient and outpatient claims are not linked; few males 18-45; few over 65
DCI Detailed Claims Information data base (National Council on Compensation Insurance)	Sample of Workers' Compensation lost work claims	Variant of ANSI Z-16.2	452,000 injury cases, including 138,000 admitted cases	1979-1987	Percent medical payments in first 6 months; disability probabilities	Longitudinal data; excludes injuries with work loss less than 3-9 days in different states
JVR Jury Verdicts Research proprietary personal injury verdicts and settlements data	Virtual census of jury awards for tort, plus selected settlements and arbitrations	Non-systematic narrative	Over 100,000 cases 1,962 product-related injury cases coded by NPSRI	1988-1995	Pain and suffering, medical and work losses	Narratives are largely free-form, creating missing data problems

Database	Population Covered	Coding Scheme	Number of Cases	Years	Data Elements Used	Comments
Missouri Discharge Data Sets	Census of discharges	ICD-9-CM 5 digits *cause-coded*	51,106 hospital-admitted, 627,135 ED-only, and 22,487 ambulatory surgery center-only injury cases	1994	Hospital readmission rate Ratio of ambulatory surgery center to hospital/ED use	Personal identifiers allowed accurate linkage of records
NAMCS National Ambulatory Medical Care Survey (NCHS)	Sample of doctor's office and clinic visits	ICD-9-CM 5 digits	4,800 injury cases	1992-1994	Payer distribution (e.g., Blue Cross, Medicaid, self-pay) Direct hospital admissions	Cases also treated in EDs are not distinguished
NEISS National Electronic Injury Surveillance System (CPSC)	Sample of hospital emergency room visits-consumer product and workplace injuries	Variant of ANSI Z-16.2	About 340,000 consumer product injury cases annually	1995-1996 1983-1986 (work-place)	Incidence by hospital admission status	Excludes direct hospital admissions
NHAMCS National Hospital Ambulatory Medical Care Survey (NCHS)	Sample of hospital emergency room visits	ICD-9-CM 5 digits cause-coded	36,686 injury cases	1992-1994	Payer distribution	Excludes direct hospital admissions
NHIS National Health Interview Survey (NCHS)	Household interview survey	ICD-9 based on respondent description	4,476 non-admitted injury cases	1987-1992	Injury counts; breakdown of non-admitted cases; work loss probability; untreated restricted activity case data	Self-report; data cover the 2 weeks prior to interview

Database	Population Covered	Coding Scheme	Number of Cases	Years	Data Elements Used	Comments
NHDS National Hospital Discharge Survey (NCHS)	Annual sample of hospital discharges	ICD-9-CM 5 digits	111,324 injury-related discharges	1987-1992	Hospital admission incidence; mean length of stay; % discharged to nursing home; payer distribution	Lack of cause codes seriously hampers analysis
NMES National Medical Expenditure Survey (NCHS)	Household interview survey, with provider follow-up	ICD-9-CM 5 digits	397 hospital-admitted, 5,439 non-admitted injury cases	1987 (most recent)	Medical costs by hospital admission status and nature of expense; visits per case	Cases identified by self-reports from 14,000 households
Pooled 5-state hospital discharge censuses	Annual census of hospital discharges	ICD-9-CM 5 digits cause-coded	586,669 live injury discharges including 292,436 consumer product injury discharges	CA 1993 MD 1994-1995 NY 1994 VT 1990 WA 1989-1991	% of cases related to consumer products, length of stay, cost data from MD and NY	Regressions modeled effects of age, sex, and consumer product injury

Figure 1. Comparison of Age & Sex Distribution: NHDS vs. Pooled 5-State Hospital Discharge Data

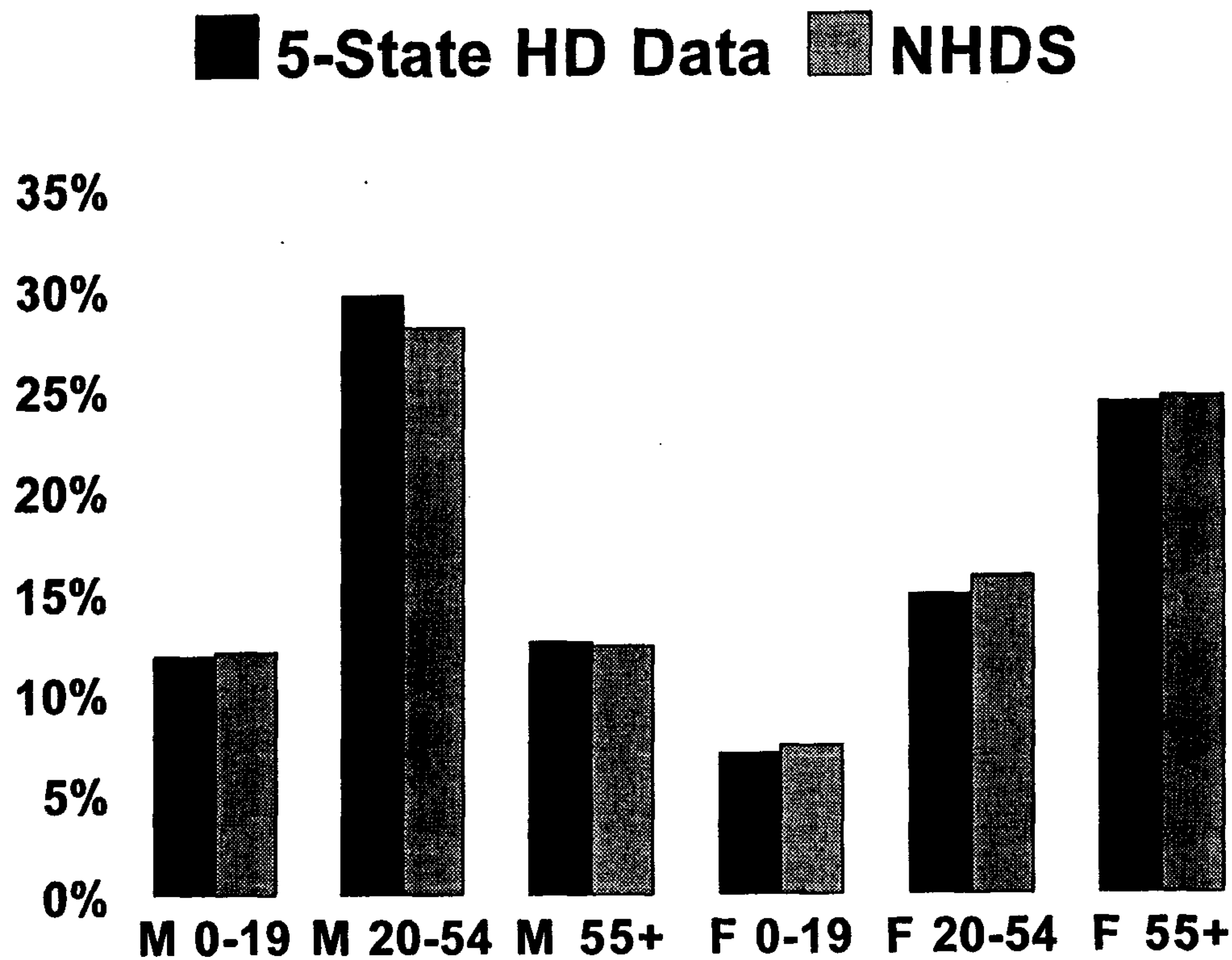

Table 2. Number of Cause-Coded Live Injury* Discharges and Statistics on Length of Stay in NHDS and Six State Hospital Discharge Censuses

		Length of Stay (*Days*)	
Data Set	Cases	Mean	Std. Dev.
NHDS 1984–86 †	41,292	6.4	NA
NHDS 1987–89	43,523	6.4	11.10
NHDS 1990–92	48,197	6.3	10.12
CHAMPUS 1986–88 †	60,000	6.0	NA
CHAMPUS 1992–94	24,150	6.3	NA
DCI 1979–87 †	138,000	6.2	NA
Combined Data from 4 States	374,324	6.1	11.28
California 1993	178,557	4.8	8.51
Maryland 1994–95	66,986	4.8	7.22
New York 1994	124,879	8.5	15.43
Vermont 1990	3,902	6.5	10.40
Washington 1989–91 @	124,777	5.9	9.90
Missouri 1994	36,285	5.7	6.82

NA = not available

* For this table, injury is defined as a primary ICD-9-CM diagnosis between 800 and 995.

† Estimate from Miller, Pindus et al. (1995)

@ Washington mean and standard deviation are for cases with a primary *or secondary* injury diagnosis.

Table 3. Comparison of Lifetime Medical Payments per Injury in Rice et al. (1989) and Miller, Pindus et al. (1995) (in 1989 dollars)

	Miller et al.	Rice et al.
All	$681	$680
Hospital Admitted	10,723	10,590
Not Admitted	248	252

Source: Miller et al. 1995, p. 34.

Table 4. Comparison of Hospital Payments (Including Professional Fees) per Injury Hospital Admission among Data Sets (in 1995 dollars)

Data Set	Cost/Case
CHAMPUS 1986-88 *	$10,830
CHAMPUS 1992-94	9,760
DCI 1979-87 *	10,304
MD/NY Average	10,646
Maryland 1994-95	8,594
New York 1994	11,720

* Estimate from Miller, Pindus, et al. (1995).

5. ESTIMATION OF INJURIES NOT TREATED AT EMERGENCY DEPARTMENTS

NEISS samples nonfatal injury victims (injury survivors) treated in hospital emergency departments (EDs) or admitted through the ED. Survivors could be treated in many other settings including ambulatory surgery centers, physicians' offices and clinics, company clinics, or poison control centers (telephone centers that triage victims and supervise home treatment). In addition, a few injury survivors are admitted to the hospital directly, by-passing the ED (and the NEISS system). These survivors may be transferred from a walk-in clinic or doctor's office, or they may be triaged by emergency medical services to a specialty hospital that lacks an ED but directly admits victims of severe trauma. The revised ICM estimates the number of injury survivors who were treated in places other than emergency departments, and then costs their injuries.[9] This chapter describes the incidence estimation; subsequent chapters describe the cost estimation. Separate incidence estimates are generated for three groups:

- Survivors treated only in non-hospital settings other than ambulatory surgery centers (e.g., physician's offices and clinics).
- Non-admitted survivors treated in ambulatory surgery centers.
- Hospital-admitted survivors not admitted through the ED.

Conceptually, ICM estimates case counts for each of these three groups from NEISS ED case counts and data about the relative frequency of cases treated only in these non-ED settings versus cases treated in the ED. For the ICM to estimate non-ED incidence, then, it needs the ratio of survivors in an incidence group per non-admitted or admitted survivor treated in the ED. This chapter describes the ratio estimation methods and the ratios for the four groups of survivors. Then it attempts to validate selected estimates.[10]

Survivors Treated Only in Non-Hospital Settings Other Than Ambulatory Surgery Centers

Ratios of injury survivors treated only in non-hospital settings other than ambulatory surgery to non-admitted survivors treated in the ED were computed from 1987–1992 NHIS

[9] The revised ICM provides costs only for medically treated injuries. Analysis of the 1987–1992 NHIS revealed that for every 4.65 medically treated injury survivors, there is an additional survivor who restricts activities but does not seek medical treatment.

[10] Validation was attempted whenever more than one nationally representative data set provided information that could be used to compute incidence ratios.

data. NHIS captures all treatment, and it differentiates ED and hospital treatment from treatment in other settings. The non-ED NHIS count includes walk-in clinics, doctor's offices, health centers, school clinics, and company clinics. NHIS separately counts untreated injuries that restricted activity for half a day or longer. We used logistic regression analyses that predicted which non-admitted survivors would be treated in the ED to estimate ratios by ICD-9 diagnosis group, sex, and broad age group (0–19, 20–54, 55 and over).[11] Motor vehicle crash victims were excluded from the data used to compute the ratios.[12]

In the mid-1970s, the National Center for Health Statistics added a one-time NHIS supplement on consumer product injuries. At that time, 41–42% of medically treated injury survivors were treated in the ED. A 1977 NAMCS supplement placed the percentage at 45%. Since that time, health-care cost controls have tried to reduce use of hospital inpatient and ED care. From 1987–1992 NHIS data, we estimate 36% of medically treated injury survivors (excluding motor vehicle injury victims) were treated in the ED (including victims admitted to the hospital through the ED). Thus, it appears that at least 5% of the cases have been diverted to less costly walk-in clinics and doctor's offices.[13]

Table 5 shows the estimated ratios of non-ED cases other than ambulatory surgery center cases to non-admitted ED cases by diagnosis grouping. The diagnosis groupings in Table 5 and most other tables in this report that come from health care data systems are in ICD-9 rather than NEISS diagnosis codes. Chapter 4 explains why and how the data were grouped. Chapter 10 explains how the grouped ICD-9 estimates were mapped to NEISS diagnosis codes. Table 5 shows ratios tailored by victim age group and sex. Controlling for injury type, females under age 55 and males under age 20 were especially likely to be treated in emergency departments. Females 55 and over seek treatment in emergency departments less often than other victims.

The share of victims who seek ED treatment varies widely by diagnosis. The non-admitted injuries with the highest chance of ED treatment were fractured clavicles and arms; open wounds of the leg, hand, neck, and head; contusions of the head and neck; and concussions. The non-admitted injuries with the lowest chance of ED treatment were trunk (generally rib) and toe fractures, internal organ injuries, crushes, eye injuries, sprains and strains, and superficial injuries.

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[11] Limited sample size forced us to use just three broad age groups. The regression variables included the sample stratifiers, age group by sex, and body region/nature-of-injury group (e.g., limb fractures and dislocations).

[12] Crash victims were excluded because crash injury incidents are not subject to CPSC authority and preliminary analysis suggested the crash victim treatment profile differs from the profile for other injuries.

[13] This percentage was the same in 1987–1989 as in 1990–1992, which confirms that it was reasonable to pool 1987–1992 data.

Example. For a female victim of a clavicle fracture (diagnosis group 810) under age 55, the ratio of non-ED cases to ED cases is .6573. For every woman under 55 who is treated for a clavicle fracture in an ED and released, we estimate that .6573 others are treated in doctor's offices and clinics.

Survivors Treated in Ambulatory Surgery Centers

An ambulatory surgery center is a facility designed as an alternative to hospital admission for medical conditions that require surgical intervention but are not so invasive they require more than a few hours of post-operative rest and observation before patients can be discharged. By appointment, some injury victims now receive their acute care at these centers, which are equipped to treat victims with comparable or more intensive treatment needs than non-admitted victims treated in the ED.

Ratios of non-admitted survivors treated in ambulatory surgery centers to non-admitted survivors treated in the ED were computed from 1994 Missouri ambulatory surgery center and ED discharge data sets.[14] Because these data sets contain personal identifiers, we were able to restrict the counts of survivors treated in the ambulatory surgery center to people whose injuries were not also treated in the emergency department or a hospital inpatient department.

Table 6 shows the Missouri diagnosis distribution by highest level where treated. The ICM ratios equal the case count in the fifth data column divided by the case count in the first data column. Diagnoses frequently treated just in ambulatory surgery centers include nose fractures, knee and shoulder joint injuries (which probably were treated arthroscopically), nerve damage, and amputations.[15]

Even in the managed care era, it appears that ambulatory surgery centers are a relatively minor source of initial injury visits. Excluding fatal incidents, Missouri emergency departments reported 627,135 non-admitted injury visits in 1994, and hospitals reported 51,106 discharges. Ambulatory surgery centers reported 22,487 injury visits; between 11.9%

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[14] NHIS was not an appropriate source of data on ambulatory surgery center treatment because it does not distinguish these cases from clinic cases and because 1987–1992 NHIS data are from a time period when most cases now treated in these centers would have been hospital-admitted. Missouri data were used as the only available comprehensive source of ambulatory surgery discharge information for a large geographic area. The National Center for Health Statistics has fielded but not yet released the data file from a survey of ambulatory surgery center discharges.

[15] Interestingly, two-thirds of injuries treated in ambulatory surgery centers that were not seen at the ED or admitted resulted from five causes -- overexertion, struck by/against, cutting/piercing, falls, and other/unspecified unintentional.

and 24.8% were follow-up care. Since an estimated 34% of non-admitted survivors are treated in the ED, about 1,217,380 (627,135 × .66 / .34) survivors were treated in doctor's offices or clinics. Thus, only an estimated 1.2% (22,487 / (627,135 + 51,106 + 1,217380 + 22,487)) of medically treated injury survivors (and presumably of medically treated consumer-product-injury survivors) are treated only at the ambulatory surgery center.

Admitted Survivors Who By-Pass the Emergency Department

Occasionally, injury victims are admitted without going through the ED. The two typical situations of this type are hospital admission from a non-ED health care treatment setting or admission to a burn center (or other specialized acute care facility) that does not have an ED.[16]

We used different procedures to estimate ratios for burn victims and other injury victims. The ratio of admitted burn victims without initial ED treatment to victims admitted through the ED was computed from NHDS and NEISS burn admission counts in Miller et al. (1993). These counts suggest roughly 60% of burn admissions go through the ED. Thus, the ratio of non-ED to ED cases is .667 (.4 / .6).

To compute the ratio for other injury victims, we first estimated the number of admissions that bypass the ED. NAMCS indicates when acute care victims treated in doctor's offices and clinics (including walk-in clinics) are transferred to the hospital. NAMCS data for 1992–1994 include only 51 direct admissions (unweighted). Therefore, except for burns, sample size dictates not differentiating non-ED admission ratios by diagnosis. The annual number of direct admissions to MIEMMS in 1992–1994 was obtained from the institution and added to the weighted NAMCS direct admission estimate. The ratio of non-ED admissions to ED admissions was computed by dividing the non-ED count by the NHDS count of total injury admissions minus the non-ED count.

NAMCS estimates 331,000 injury victims are admitted from clinics and doctors' offices annually. MIEMMS admits about 100 patients a week, 5,200 annually[17]. By comparison about 2,570,000 injury victims other than burn victims are admitted annually through the ED. Thus, we estimate that NEISS captures about 88.4% of non-burn injury admissions. The ratio of non-ED to ED cases is .131 (.116 / .884).

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[16] A unique example of such a facility is the Maryland Institute of Emergency Medical Services (MIEMMS), which treats severe trauma victims state-wide. It admits patients based on triage at the scene.

[17] Personal communication, Pat Dischinger, MIEMMS, April 1997.

Validation of Relative Frequency of ED-Treated Versus Other Non-Admitted Injury

NHIS suggests that 48% of non-admitted injury victims treated in EDs, doctor's offices, or clinics are treated in the ED. That percentage closely matches the estimate of 49% from NCHS provider surveys -- NAMCS, which collects data from doctor's offices and clinics, and the NHAMCS ED sample. These NHIS estimates exclude victims who were treated only in ambulatory surgery centers, company clinics, school health clinics, and outpatient clinics.

Because only a small portion of doctor's office and clinic visits are injury-related, NAMCS injury sample sizes often are small, making comparisons by diagnosis tenuous. Even where sample sizes are adequate, the differences between data sets are striking for some diagnoses. Coding practices are the likely cause. For example, no NHAMCS cases use ICD-9 diagnosis code 842, wrist/hand sprain. Also, the NHIS self-reported diagnoses seem to sort sprained knee/lower leg versus sprained ankle/foot differently than the provider reports. Nevertheless, while coding practices prevent the ratios of non-admitted survivors treated by doctors versus EDs from agreeing by ICD-9 diagnosis group, the overall NHIS ratio estimates agree reasonably well with the NAMCS-NHAMCS ratios obtained from providers. That increases our confidence in ICM's overall estimate of non-admitted injury victims not treated in the ED.

Table 5. For Medically Treated, Non-Admitted Injury Survivors: Ratio of Number Treated in Non-ED Settings to Number Treated in the ED, by Victim Diagnosis Group, Sex, and Age Group

Diagnosis Group		Male GE 55	Male 20-54	Male 0-19	Female GE 55	Female 0-54 *
800-804	fracture head	1.3540	1.4944	1.1255	1.8831	1.3540
805-809	fracture trunk, neck	7.3540	8.1170	6.1131	10.2281	7.3540
810	fracture clavicle	0.6573	0.7255	0.5464	0.9142	0.6573
812-819x	fracture arm	1.2768	1.4093	1.0614	1.7758	1.2768
815-817	fracture hand	2.0574	2.2708	1.7102	2.8614	2.0574
820-829x	fracture leg	1.8422	2.0334	1.5314	2.5622	1.8422
826	fracture toe	3.1829	3.5131	2.6458	4.4268	3.1829
830-839	dislocation	2.7047	2.9853	2.2483	3.7618	2.7047
840,841	spr/strain arm,shoulder	3.1800	3.5099	2.6434	4.4228	3.1800
842	spr/strain wrist, hand	2.3754	2.6219	1.9746	3.3038	2.3754
843,844	spr/strain leg, knee	3.3627	3.7115	2.7952	4.6768	3.3627
845	spr/strain ankle, foot	1.7965	1.9829	1.4934	2.4986	1.7965
846,847	spr/strain back	2.8622	3.1592	2.3792	3.9808	2.8622
848	spr/strain misc	4.9916	5.5095	4.1493	6.9425	4.9916
850	concussion	1.4034	1.5490	1.1666	1.9519	1.4034
851,854	other head injury	1.8123	2.0003	1.5065	2.5206	1.8123
860-869	internal organ injury	6.6245	7.3118	5.5066	9.2135	6.6245
870-874	open wound head, neck	1.1843	1.3071	0.9844	2.2996	1.6517
875-880	open wound body	1.5436	1.7037	1.2831	2.9973	2.1528
881,884	open wound arm	1.3767	1.5196	1.1444	2.6733	1.9201
882	open wound hand	1.1921	1.3158	0.9910	2.3148	1.6627
883	open wound finger	1.3949	1.5397	1.1595	2.7086	1.9455
890,891	open wound leg	0.9470	1.0453	0.7872	1.8389	1.3208
892,893	open wound foot, toe	2.6369	2.9105	2.1919	5.1202	3.6777
904	blood vessel injury	3.0931	3.4140	2.5711	4.3019	3.0931
911-917	superficial (not head)	4.8742	5.3799	4.0517	6.7791	4.8742
910,918	superficial head, eye	2.0659	2.2802	1.7173	2.8732	2.0659
919	superficial misc/mult	4.0342	4.4527	3.3534	5.6108	4.0342
920	contusion head, neck	1.2504	1.3802	1.0394	1.7391	0.7592
921	contusion eye	3.5939	3.9668	2.9875	4.9985	2.1821
922	contusion trunk	2.3752	2.6217	1.9744	3.3035	1.4422
923	contusion upper limb	1.4988	1.6543	1.2459	2.0846	0.9100
924	contusion lower limb	2.3942	2.6426	1.9902	3.3299	1.4537
925-929	crushing injury	6.5901	7.2738	5.4780	9.1656	6.5901
930	foreign body eye	3.5742	3.9450	2.9711	4.9710	3.5742
931-939	foreign body (not eye)	2.0523	2.2652	1.7060	2.8543	2.0523
940,941	burn head, eye	1.6232	1.7916	1.3493	2.2576	1.6232
942-949	burn (not head)	2.0643	2.2785	1.7160	2.8711	2.0643
950-957	nerve damage	1.9229	2.1224	1.5984	2.6744	1.9229
959	misc injury	2.1211	2.3411	1.7631	2.9500	2.1211
960-989	poison	1.9228	2.1223	1.5983	2.6742	1.9228
990-994	misc external cause	2.8217	3.1145	2.3456	3.9245	2.8217

Source: Tabular analysis of 1,260 ED-treated-and-released cases and 2,432 other non-admitted, medically treated cases in 1987-1992 NHIS data. Differentiation by age and sex calculated by logistic regression analysis. Excludes victims of motor vehicle crashes.

* Values for females ages 0-19 and 20-54 did not differ significantly.

Table 6. Distribution of Diagnosis Groupings by Highest Level Where Treated

ICD Grouping	Emergency Department		Hospital-Admitted		Ambulatory Surgery	
	Cases	Percent of Group	Cases	Percent of Group	Cases	Percent of Group
800-804 Fract HFN (excl. Nose)	645	39.32 %	983	59.93 %	12	0.73 %
802.0-802.1 Fract Nose	3108	80.06 %	125	3.22 %	649	16.71 %
805-809 Fract Vertebr	4533	59.27 %	3077	40.23 %	38	0.49 %
810-811 Fract Clav/Scap	3439	93.40 %	216	5.86 %	27	0.73 %
812-814,818 Fract UpLimb	20939	84.97 %	2659	10.79 %	1044	4.23 %
815-817 Fract Hand	15458	93.11 %	339	2.04 %	804	4.84 %
820-825.5,827-829 Fract LL/Unsp	15565	49.95 %	14756	47.35 %	840	2.69 %
826 Fract Toe	3449	95.01 %	118	3.25 %	63	1.73 %
830-839 Dislocation	8013	55.81 %	661	4.60 %	5683	39.58 %
840-841 Sprain UpLimb	10304	81.50 %	1033	8.17 %	1305	10.32 %
842 Sprain Wrist/Hand	14136	98.10 %	41	0.28 %	232	1.61 %
843-844 Sprain LowLimb	12328	90.76 %	493	3.62 %	762	5.61 %
845 Sprain Ankle/Foot	31664	99.00 %	191	0.59 %	127	0.39 %
846-847 Sprain Back	54629	98.16 %	918	1.64 %	103	0.18 %
848 Sprain Oth/Ill Def	5598	98.17 %	92	1.61 %	12	0.21 %
851-859 Other Head Inj	12716	85.45 %	2146	14.42 %	18	0.12 %
850 Concussion	3114	82.35 %	659	17.42 %	8	0.21 %
860-869 Internal Inj	792	29.97 %	1761	66.65 %	89	3.34 %
870-874 Open Wound HFN	65948	97.26 %	1251	1.84 %	604	0.89 %
875-880 Open Wound Oth/UA	4555	89.61 %	427	8.40 %	101	1.98 %
881,884 Open Wound Arm	12136	95.13 %	431	3.37 %	190	1.48 %
882 Open Wound Hand	15788	96.92 %	251	1.54 %	250	1.53 %
883 Open Wound Finger	37886	97.71 %	221	0.57 %	666	1.73 %
885-886,895-896 Amput Fing/Toe	1260	77.77 %	162	10.00 %	198	12.22 %
887,897 Amput Arm/Leg	20	35.08 %	29	50.87 %	8	14.03 %
890-892,894 Open Wound LowLimb	15259	95.51 %	523	3.27 %	193	1.20 %
893 Open Wound Toe	10438	96.22 %	262	2.41 %	147	1.35 %
900-904 Blood Vessel	199	50.89 %	166	42.45 %	26	6.64 %
910,918 Superfic HFN	16214	98.71 %	202	1.09 %	36	0.19 %
919 Superfic Oth/Unsp/Mult	3305	97.32 %	82	2.41 %	9	0.26 %
920-924 Superfic All Oth	18962	96.82 %	495	2.52 %	126	0.64 %
920 Contusion HFN	22364	97.96 %	440	1.92 %	24	0.10 %
921 Contusion Eye	2749	94.40 %	142	4.87 %	21	0.72 %
922 Contusion Trunk	15393	96.35 %	546	3.41 %	37	0.23 %
923 Contusion UpLimb	29076	99.20 %	206	0.70 %	28	0.09 %
924 Contusion LowLimb	32575	97.38 %	816	2.43 %	59	0.17 %
926-929 Crush	2037	92.21 %	92	4.16 %	80	3.62 %
931-939 Foreign Body All Oth	7638	85.13 %	848	9.45 %	486	5.47 %
930 Foreign Body Eye	6949	98.67 %	7	0.09 %	86	1.22 %
940-941 Burn HFN	3357	94.80 %	179	5.05 %	5	0.14 %
942-949 Burn All Othr	10621	90.58 %	1026	8.75 %	78	0.66 %
950-957 Nerve Damage	400	50.82 %	211	26.81 %	176	22.36 %
958 Early Complication	658	72.22 %	214	23.49 %	39	4.28 %
959 Inj Other/Unspecified	23526	97.88 %	375	1.56 %	134	0.55 %
960-989 Poison/Toxic	18479	81.16 %	4232	18.58 %	57	0.25 %
990-994 Environment	2053	81.08 %	368	14.53 %	111	4.38 %
97 unknown	21127	73.04 %	5779	19.98 %	2016	6.97 %
99 unknown	2451	92.94 %	183	6.93 %	3	0.11 %

Source: Tabulated from 1994 Missouri discharge censuses.

6. MEDICAL COST ESTIMATION

This chapter derives the estimated medical costs per injury by diagnosis. Separate estimates were developed for hospital-admitted victims, victims treated in the ED and released, and victims treated only in doctor's offices or in clinics.[18] We were able to tailor the estimates for admitted victims to consumer product injury by victim age and sex.

From society's perspective, costs of fee-for-service medical care are defined as the amount that patients and other payers pay for the care. For capitated care, costs per service are assumed to equal the costs for comparable services delivered on a fee-for-service basis.

Two states, Maryland and New York, regulate the relationship between costs and charges for hospital care by department or service.[19] These states have accurate hospital production cost data. Because virtually all hospitals in these states operate on a non-profit basis, the regulations force average payments (societal costs) to equal production costs. The revised ICM incorporates these costs from Maryland and New York, with some adjustment to make them more nationally representative.[20]

The payment, or reimbursement, is the amount the provider collects for the services rendered. Total payments (by patients and other payers) measure societal costs of medical treatments. Payments for the same X-ray by the same provider vary from patient to patient

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[18] We assumed that costs for ambulatory-surgery-center cases are the same as costs for ED-treated cases of the same diagnosis.

[19] The most readily available information about fee-for-service health care typically is charges taken from the bill. But charges are unacceptable surrogates for costs for two reasons. First, the charge includes an allowance for bad debt. That means average charges per victim times the number of victims double-counts charity care costs. Second, Medicare requires participating providers to charge everyone the same amount for the same service; Medicare and other health insurers then pay a fraction of the bill according to widely varying negotiated rates or fee schedules. Consequently, medical care bills rarely are paid in full. Because payments typically are only a percentage of charges, providers must charge more than their production costs to break even. Charges, therefore, do not reflect costs as well as payments do.

[20] We believe the two-state data are more accurate than hospital charge data adjusted with medicare cost-to-charge ratios. That approach yields a reasonably good estimate of total hospital costs, but a surprisingly poor estimate of costs by hospital department or service. Injury and illness victims differ in patterns of ancillary service utilization and in case mix. Consequently, most studies of Medicare reimbursement of trauma care find that payments typically cover half of actual trauma care costs (Champion and Mabee 1990, U.S. General Accounting Office 1991).

depending on their payment source. Average payments across all patients represent costs (including a fair provider profit) accurately. Average payments by specific payers, however, may not closely mirror the overall average, especially for hospital care.[21] The comparisons at the end of Chapter 4 suggest that CHAMPUS payments (including co-pay) are an accurate surrogate for the average patient/payer costs of non-admitted medical care. For non-admitted cases, ICM uses this surrogate.

This chapter describes the medical care costing methods and cost estimates. It starts with admitted cases, followed by non-admitted ED and non-ED cases. A table at the end of the chapter summarizes lifetime medical costs by place of treatment (hospital-admitted, non-admitted ED, and other non-admitted) and NEISS body part or nature of injury diagnosis.

Costs for Hospital-Admitted Cases

Hospital-admitted injury survivors usually have the highest severity and costs per nonfatal case. Perhaps as a result, more data are available about these victims than other injury survivors. Given the importance of admitted cases and the availability of data about them, estimating costs for these cases was complex. The overall estimate is built from diagnosis-specific estimates in 7 steps:

1. Estimate length of stay per admission
2. Estimate ratio of professional fees to hospital costs (This step is necessary because hospital cost data exclude most professional fees.)
3. Compute hospital costs and professional fees per admission from length of stay
4. Multiply hospital costs per admission by admissions per admitted victim
5. Add pre-hospital and post-discharge acute care costs
6. Estimate lifetime costs from short-term costs
7. Include health care claims processing costs

Figure 2 shows the flow of the analysis. Steps 1 and 3 each have discrete substeps. Figure 3 summarizes the analysis in equation form.

The estimated costs are based on injury cases that appear likely to be associated with consumer products. They are differentiated by victim sex and age group (0–19, 20–54,

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[21] For unsubsidized doctors and hospitals to remain in business, payments must at least cover costs including costs of charity care. Therefore, average payments per patient with payments must include an allowance for bad debt; applying this average to all patients double-counts charity care costs. To the extent non-payment is less frequent for small doctor bills than large hospital bills, payment data from a single payer are more credible cost surrogates for non-admitted than admitted cases.

55–69, 70 and over).[22] We assessed the possibility of separately estimating medical costs for hospital-admitted children ages 0–9 versus 10–19. We decided against separate estimates because costs per admission generally were quite similar for the two age groups (mostly because they had comparable lengths of hospital stay for comparable diagnoses) and sample sizes were often small when data from the two age groups were not pooled.

This section describes how the costs for hospital-admitted victims were derived and briefly describes the cost patterns. Medical costs per injury victim were estimated for 779 ICD-9-CM diagnosis groups, then mapped to NEISS codes.

As the next sub-section describes, the analysis covered injury victims identified by a traditional diagnostic guideline (an ICD-9 diagnosis code between 800 and 995), as well as victims identified by injury cause code. The latter group of victims often have diagnoses like "pneumonia," "back pain," or "complications of pregnancy" that sometimes result from injury and sometimes result from other causes.

Subsequent subsections explain how each of the seven cost elements was estimated and summarize the estimates. Each subsection concludes by contributing to a running example, which continues in Chapters 7–9 and is reproduced in Appendix A. The example builds a step-by-step cost estimate for a 40-year-old woman's fractured scapula (i.e., shoulder blade, ICD-9 diagnosis 811). This section's example builds a cost estimate for a hospital-admitted victim, while the following section builds a comparable estimate for a non-admitted victim

Estimates of medical cost components were generated for 779 ICD-9 diagnosis groups. Here, we merely summarize the results.

Identify and Classify Injuries in Hospital Discharge Data. As Chapter 4 states, the NHDS and state hospital discharge data sets used to estimate medical costs for admitted cases all code patient diagnoses with the International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9-CM). Depending on the data set, hospital discharge records may list from 5 to 24 ICD-9 diagnoses per patient. Two steps were taken to prepare these data sets for cost analysis. First, we determined which patients were injured. Next we chose the most appropriate single ICD-9 diagnosis code for each patient, which we called the classifying diagnosis.[23] Once these steps were completed, we could compute average costs

[22] Limited sample size forced us to use just a few broad age groups.

[23] Classification was more complex because ICD-9 diagnoses often do not match NEISS diagnoses exactly. Furthermore, injury coding is erratic enough that the diagnoses coded for a given patient may vary between coders. The differences are especially severe when payer cost controls lead to better reimbursement for some diagnoses than for others. This problem introduces noise into our estimates.

per case by classifying diagnosis, age group, and sex, then as Chapter 10 describes, map them into NEISS diagnosis codes.

To support the mapping, we needed to capture and cost the full range of injuries that might relate to consumer products. In data sets that include injury cause coding, we initially captured all cause-coded cases. The large majority of patients with injury cause codes had diagnoses like fractured leg and arm contusion that obviously described injuries.

When the patient's diagnoses did not include obvious injuries (ones with diagnosis codes between 800 and 994, which the ICD-9 codebook titles Injuries and Poisonings), we had to decide whether the injury cause code appeared in error. From a frequency count, we identified diagnosis codes below 800 that almost always were cause-coded (for example, ICD 310.2, post-traumatic concussion syndrome) and classified them as injuries. The first table in Appendix B lists these diagnoses. We hand-examined the remaining records and either deleted them or identified a diagnosis like dermatitis that sometimes but not always results from injury.[24] This process yielded the second table in Appendix B, which lists diagnoses that sometimes or always resulted from injury. In data sets without cause coding, we developed cost estimates for all cases with diagnoses on these lists. In weighting the diagnosis-specific data into NEISS groupings, we accounted for the relative frequency of injury versus non-injury incidents within these diagnoses.

Once we selected the injury cases, we chose a classifying diagnosis code for each case. If the first diagnosis listed in the patient's discharge record was a traditional ICD-9 injury diagnosis (ICDs 800–994) or one of the 17 other injury diagnoses listed in the first table of Appendix B, we chose that diagnosis. Depending on the data set, first-listing in the discharge record may imply that the diagnosis was the primary cause for admission (the NHDS rule) or that it was the principal contributor to overall length of stay (the rule in all the state files except Washington, where our file had diagnoses sorted in numerical order).

For 80% of the injury discharges in the state files (except Washington), the first-listed diagnosis was an injury as traditionally defined. For other first-listed diagnoses, we classified the victim by the first listed traditional injury diagnosis or diagnosis from Appendix B, Table B1. If none was listed, we classified by the first diagnosis that we considered might be an injury, as listed in Appendix B, Table B2. For example, if the external cause of injury code was poisoning of unknown intent with solid or liquid, the first diagnosis was ICD 296.2 (single major depressive disorder) and the only secondary diagnosis was ICD 507

[24] A difficult judgment was required when the patient's only injury-related diagnosis was cellulitis and abscess. This diagnosis can result from diabetes, for example, or be a complication of an untreated or improperly treated wound. If the case was cause-coded and contained no illness-related diagnoses, we accepted it as a legitimate complication-of-injury case even though we did not know what body part was injured.

(pneumonitis due to solids and liquids), we classified the injury as ICD 507. Among all injury cases, 97% ultimately were classified with a traditional injury diagnosis.

Next, we developed a method to classify cases with diagnoses of late-effects-of-injury or complications of injury (e.g., cellulitis and abscess). Such cases conceivably could be first medical encounters for injury or return visits. We analyzed this question using the Missouri hospital, emergency department, and ambulatory surgery center discharge files. Since complication cases treated in January 1994 generally would link to 1993 initial treatment, meaning Missouri did not collect data about them, we excluded January cases. Among the remaining cases, 58% of patients treated in the emergency department and 61% of patients admitted to hospital for late effects of injury or complications of injury sought treatment for injuries that had not been treated previously in the hospital inpatient department, emergency department, or ambulatory surgery center. A few of these patients might have been treated previously in physicians' offices.[25]

Fifty-seven percent (57%) of late-effects-of-injury cases and 79% of injury complications cases were first medical visits. The first-medical-visit patients tried to wait out their injury, only seeking medical treatment when complications arose. Consequently, their treatment was unnecessarily expensive. In NEISS, late-effects victims without prior medical treatment usually would be classified as acute injury victims. Other late-effects cases are readmissions or follow-up treatments.

Finally, we identified which injuries were consumer product-related. We applied the classification criteria CPSC developed in Kessler and Reiff (1995), which uses ICD-9 external-cause-of-injury codes to define consumer product injuries. Three cause categories accounted for most of the injuries excluded from the consumer-product designation: transportation, adverse effects of medical treatment, and intentional injury. For cause codes where Kessler and Reiff included less than 100% of qualifying injuries -- injuries with location codes specifying recreation, residential institutions, public buildings, and other specified places -- we treated all cases as consumer product injuries. In the pooled 5-state data, 49.8% of cause-coded live injury discharges were identified as potentially related to consumer products.

Estimate Length of Stay. Nationally representative average lengths of stay by diagnosis group came from NHDS. For the same injury diagnosis, average length of stay for victims of consumer product injury may differ from the average for another cause like motor vehicle injury. Since NHDS does not describe injury cause, we used the 5-state pooled hospital discharge data to adjust the NHDS lengths of stay to estimated lengths of stay for consumer product injury. Because victim age and sex may affect the likelihood that an injury

[25] If equal proportions were treated in physicians' offices and EDs, which seems unlikely given that the available data reveal a strong tendency to return to the initial source of treatment, roughly 40% would not have been treated previously.

was consumer-product related as well as affecting length of stay directly (e.g., if older people recover more slowly than youth), we used the 5-state data to adjust the product-injury lengths of stay for age-sex variations. For 63 diagnosis groups, log-linear regressions that estimated length of stay (the dependent variable) as a function of age group, sex, and whether the injury was caused by a consumer product allowed us to tailor the NHDS average length of stay to fit the victim.

Generally, victims under age 20 have below-average lengths of stay. Those over age 54 and especially over age 69 have above-average lengths of stay. The effect of a consumer product etiology versus another etiology on length of stay typically is statistically significant at the 95% confidence level; the direction of the effect varies with the mix of other causes associated with a given diagnosis. Overall, length of stay for consumer product injuries is below the all-injury average.

Example. For scapula fractures, the NHDS length of stay averages 4.2 days. The regression on pooled 5-state data shows the length of stay for consumer product-related scapula fractures of women ages 20–54 is 80% of the average for all scapula fractures. Multiplying 4.2 by 80%, we estimate that the length of stay for our victim would be 3.36 days.

Estimate Ratio of Professional Fees to Hospital Costs. Professional fees include payments to physicians and allied health personnel (e.g., inhalation therapists, physical therapists) whose services are not bundled into the hospital bill. By 3-digit ICD-9 diagnosis, we estimated the ratio of professional payments to hospital payments per admission as annual CHAMPUS professional payments for inpatient care divided by annual CHAMPUS hospital payments.

The ratios vary widely. The average ratio is 30.5% for traditional injury diagnoses (ICDs 800–994), but much higher, 48%, for the broader range of diagnoses including conditions that are often, but not always, the result of injuries. At the low end, professional fees were no more than 7% of hospital payments for post-traumatic concussion syndrome, cerebral lacerations and contusions, trunk crush and fracture, and many burns and poisonings. Conversely, professional fees were at least twice hospital payments for many injury-related complications of pregnancy, carpal fracture, traumatic cataracts, chemical fume inhalation, back or abdominal pain, shoulder dislocation, open wounds of the chest or upper limb, and cranial nerve injury. We multiplied the professional-fee ratios by the hospital cost estimates to estimate total inpatient costs.

Example. For a fractured scapula, CHAMPUS shows the ratio of professional fees to hospital payments is .1814. The total costs incurred during a hospital admission for scapula fracture will be 1.1814 times the hospital's costs. This information will be used in the next step.

Compute Hospital Costs and Professional Fees from Length of Stay. National data were not available on the fixed and variable costs of hospital stays for injury. Furthermore, many health care data sets restricted their fiscal data to charges. Payers typically negotiate the percentage of charges that they will pay to a hospital. The percentages vary widely between payers and between hospitals. Consequently, provider costs and even payments for service typically bear little relationship to charges.

Hospital inpatient cost information came from Maryland and New York, the only states with cost-control regulatory agencies that require hospitals to maintain fixed, known relationships between costs and charges at the service rather than facility level (meaning accurate costs of trauma care, orthopedic care, neurologic care, etc. are available).[26] Both states collect data on charges and hospital-specific multipliers that can be applied to compute accurate costs of care for individual patients. To estimate national costs, we multiplied the state costs times the ratio of average cost per hospital day in the United States versus the state (Statistical Abstract of the U.S. 1996, table 191). We analyzed 1994–1995 Maryland data and 1994 New York data. The 1995 Maryland costs were converted to 1994 equivalents using the Hospital Room component of the Medical Care Services Consumer Price Index (Statistical Abstract of the U.S. 1996, table 171). As noted in Chapter 4, the adjusted two-state cost data were consistent with payment data from CHAMPUS and DCI.

New York, which has much longer lengths of stay than Maryland (see Table 2), has lower costs per day. A hospital admission has fixed costs (e.g., admission and discharge paperwork) and front-end costs (e.g., emergency department and surgical theater use), plus daily costs. We ran about 700 regressions by ICD-9 diagnosis group to estimate the fixed cost component and the average daily variable cost.[27] The regressions grouped diagnoses in order to obtain large enough samples to analyze.[28] The diagnosis-specific professional-fee-to-hospital-cost ratios had to be applied to the diagnosis-specific hospital costs before grouping. (In our example, the cost of a broken scapula was multiplied times 1.1814.) Thus the regressions predicted hospital cost plus professional fees as a function of length of stay. If the regression intercept was negative (suggesting a diagnosis group had insignificant fixed cost), we used the average hospital cost plus professional fees per day. The regressions analyzed only the 122,605 probable consumer product injury cases in the Maryland and New York files; all other injuries were excluded.

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[26] No other states collect cost data that are reasonably accurate at the diagnosis level.

[27] We used simple, one-independent-variable regressions of the form Total Cost = a + b × Length of Stay. The fixed cost component is a and the variable component is b.

[28] Grouping was impossible for some diagnoses below ICD-9 code 800 The regressions for those below-800 diagnoses are quite tenuous.

The cost of a hospital admission was computed by multiplying the length of hospital stay by the average variable cost per day of stay, then adding the fixed costs of a stay.

Including hospital costs and professional fees, by far the highest costs per day of stay (including the variable costs and average fixed costs per day) were for injury-related complications of pregnancy (caused by a fall, for example). The costs sometimes exceeded $10,000 per day (in 1994 dollars). Many joint injuries -- internal derangement, dislocation or cruciate ligament sprains of the knee, carpal fractures, shoulder dislocations, and rotator cuff sprains -- cost $3,000 to $4,000 per day. By comparison, the average cost per day for consumer product injury was $1,270. Importantly, the injuries with high daily costs typically required only 2–3 days of hospitalization, less than half the all-injury average.

Example. The regression equation for a hospital-admitted scapula fracture (in 1994 dollars) is:

Cost = $2038.60 + ($740.40 × Length of Stay)

In this equation, the dollar amounts are the coefficients estimated by the regression. For the mean length of stay of 3.36 days, the estimated cost is $4,526.

<u>Multiply Hospital Admissions per Victim by Cost per Admission</u>. Hospital discharge data sets typically do not distinguish initial hospital admissions from follow-up admissions. That means only costs per admission are readily computed from these data sets. Data on admissions per victim allowed calculation of costs per victim from costs per admission.

We used 1994 Missouri hospital discharge data to analyze hospital admissions per injury victim by injury diagnosis. Follow-up admissions (readmissions) include admissions to rehabilitation hospitals, follow-up of bad initial outcomes, and planned admissions to complete staged procedures (for example, a leg with a complex fracture may be cleaned, the patient sent home while the swelling subsides, then the leg reconstructed in a follow-up admission). The data were grouped to include at least 30 discharges per diagnosis group. Because the Missouri data contained patients' names and social security numbers, the admission linkage should be quite accurate. To avoid problems with multi-year episodes, we excluded December initial admissions from the analysis.

On average, 9.5% of hospital-admitted injury victims are readmitted. Readmission rates are less than 4% for pregnancy complications, internal injuries, sprains, strains, open wounds, superficial injuries, and poisonings. They exceed 15% for spinal cord injury, pelvis fracture, femur fracture, late effects of injury, and nerve injury.

Example. The average scapula fracture results in 1.072 hospital admissions. Multiplying 1.072 by the $4,526 cost per admission yields total hospital costs of $4,852.

<u>Add Pre-Hospital and Short-Term Post-Discharge Costs</u>. Some costs are incurred before the victim reaches the hospital. Others are incurred after discharge. NMES provided the ratio of inpatient payments to short-term pre-hospital and post-discharge spending (on

average, six months after discharge). Pre-hospital spending covers ambulance transport and life-support services. Post-discharge spending pays for physicians, allied health providers, home health care, prescriptions, and ancillary goods like canes and colostomy bags. As Table 7 shows, payments for these items average 11.8% of inpatient payments. The bulk of the expense covers physician visits and home health care. We multiplied the post-discharge ratio times the inpatient cost estimates to estimate short-term costs. The NMES sample is so small that we could not differentiate this ratio among diagnoses.

Overall, estimated short-term costs average $11,839 per hospital-admitted consumer product injury victim (in 1994 dollars). The estimates average about $600 less for injury victims with ICD-9 diagnosis codes above 800 than for other cause-coded injury victims.

Example. Estimated pre-hospital and short-term post-discharge costs for a fractured scapula are 11.8% of $4,852, or $573. Total short-term care costs equal $5,425 ($4,852 + $573).

<u>Estimate Lifetime Costs from Short-Term Costs</u>. NMES only provides costs for the first six months after hospital discharge. The DCI provided data by diagnosis group on the percentage of lifetime medical payments paid in the first six months after injury. These percentages appear in Pindus et al. (1990, 1991). We divided the short-term costs by the percentage paid in the short term to estimate lifetime costs.

Miller, Pindus et al. (1995) concluded that the DCI did not fully capture lifetime costs for paralyzing spinal cord injuries or for catastrophic injuries resulting in multi-year institutionalization in a nursing home. We added these costs in two steps. First we estimated probabilities of nursing home admission and length of stay if admitted. Second, we estimated cost per year of stay.

For spinal cord injury, we used nursing home, attendant, and other post-discharge costs from the national household survey by Berkowitz et al. (1990). Miller, Pindus, et al. (1995) provide details about this survey and its estimates. For burn victims, Miller, Brigham et al. (1993) estimate the probability of nursing home admission following hospital discharge at 3.8%, computed from California discharge destinations. Stays averaged two years. For anoxia, aspirated foreign object, submersion, and traumatic brain injury cases, we computed nursing home admission probabilities from NHDS data. The probabilities were .115, .151, .018, and .103, respectively. We assumed discharge to nursing home for these injuries implied lifetime skilled nursing care, but a residual average lifespan of 10 years.

Bureau of the Census (1996) reports an annual cost of $84,285 (inflated to 1995 dollars using the CPI–All Items) for custodial care in a public mental retardation facility. Miller et al. (1989) suggest using this cost as a surrogate for ICF cost. They also estimate the average cost of a year in a Skilled Nursing Facility (SNF) is at least double the cost in an ICF. For catastrophic injuries, where SNF care is required, we use twice the ICF cost.

Example. DCI data show short-term costs are 69.11% of the total medical costs of a hospital-admitted fractured scapula. Dividing $5,425 by 69.11%, we estimate total medical costs for a 40-year-old woman admitted with a scapula fractured in a consumer-product incident will be $7,850.

Include Claims Processing Costs. The final medical cost factor accounts for the cost of processing medical payments. Claims processing costs are a fraction of medical claims payments, which varies by payer. Published insurance statistics, plus studies of Medicare and Medicaid claims processing costs, provided the payer-specific ratios of claims processing costs to claims payments shown in Table 8. For admitted cases, NHDS shows the distribution of payers, which varies by injury diagnosis. By diagnosis, we computed an average ratio of processing costs to payments. Multiplying these ratios by the medical costs yields the processing cost estimates. Across all cases including self-pay cases, claims processing costs average 5% of the medical care costs for a hospital-admitted injury, with a range from 3% to 10% across diagnoses.

Example. For a fractured scapula, NHDS suggests claims processing costs will average 5.57% of total medical payments. Multiplying 5.57% by $7,850, estimated claims processing costs are $437. Total estimated health care costs for the fracture equal $8,287 ($7,850 + $437).

Summary of Medical Costs per Admission by NEISS Diagnosis Category. Table 9 summarizes lifetime medical cost per survivor of a consumer product injury by place of treatment, age group, and sex. The left panel of the table shows costs by NEISS nature of injury code. Nerve damage and hemorrhage have the highest costs per admitted case. Electric shock, concussion without skull fracture, and ingested foreign object have the lowest costs per admitted case. These conditions all are ones where victims sometimes are admitted briefly for observation. The right panel of Table 9 shows average costs by NEISS body part code. The highest average costs for admitted cases are for injuries to the head, neck, wrist, and upper leg and injuries (generally burns) that affect at least 25% of the body.

Costs for Non-Admitted Cases

ICM uses medical payments per fee-for-service visit or ancillary expense as a proxy for costs for non-admitted victims. This section describes the steps involved in deriving medical spending per medically treated, non-admitted injury survivor and segmenting the cost estimates by medical treatment level. Recall that ICM not only costs the non-admitted ED cases captured by NEISS but uses these cases to estimate and cost non-admitted cases treated only in other settings.

Medical cost estimation for non-admitted cases was severely constrained by data availability. CHAMPUS provides costs for a rich range of diagnoses but does not differentiate costs of ED care from care in other non-admitted settings. NMES differentiates costs by treatment setting but contains so few cases that costs only can be stated separately for very broad diagnosis groups like dislocations or superficial injuries. The challenge was to use the two data sets to arrive at diagnosis-level cost estimates by highest level where treated.

The bottom section of Figure 3 summarizes the analysis in equation form. The overall estimate is built from diagnosis-specific data in six steps:

1. Estimate short-term medical payments per visit
2. Break out estimated payments per visit for non-admitted ED versus non-ED cases
3. Multiply payments per visit by visits per case
4. Add ambulance, prescription, and ancillary payments
5. Estimate lifetime costs from short-term costs
6. Include claims processing costs

Like the previous section, this section describes each step. It also develops costs for a non-admitted scapula fracture, which serves as a continuing example in Chapters 6–9.

Estimate Short-Term Medical Payments per Visit. Short-term medical payments per non-admitted medical visit by ICD-9 diagnosis came from CHAMPUS. As Chapter 5 stated, CHAMPUS data are not disaggregated by age or sex.

Example. For a scapula injury, CHAMPUS reports payments per non-admitted medical visit average $184 (in 1995 dollars).

Break Out Estimated Payments per Visit for ED versus Non-ED Cases. Guided by NMES data on costs per non-admitted visit by diagnosis group and highest level where treated (non-admitted ED versus non-ED) and by NHIS data on relative numbers of non-admitted ED versus non-ED cases, we split the CHAMPUS provider payments into estimated payments per visit by highest level where treated. Cases treated both in the ED and a non-hospital setting were classified as ED cases.

Example. For scapula fractures originating in the ED, including follow-up visits to other treatment settings, payments per visit average $130. Payments per visit for cases originating in doctor's offices or walk-in clinics average $335. (This pattern is atypical. For most non-admitted injuries, the costs per visit are higher for cases originating in the ED.)

Multiply Costs per Visit by Visits per Case. The costs per visit were multiplied times NMES visits per case for the relevant treatment setting and diagnosis group.

Example. ED-treated scapula fractures average 3.68 visits per case; doctor's office cases average 2.02 visits. That means ED-treated cases have average CHAMPUS-based costs of $478 (3.68 × $130) and doctor's office cases have average costs of $677 (2.02 × $335).

Add Ambulance, Prescription, and Ancillary Care Costs. CHAMPUS cost reports exclude payments for ambulance transport, prescriptions, and ancillary care. We added NMES data on these costs by highest level where treated (non-admitted ED or other) and diagnosis group.

NMES describes utilization for an average of six months after injury. Thus, the CHAMPUS/NMES estimates represent the short-term costs of medical care by diagnosis and highest level where treated.

Short-term costs per ED case are typically about one-third higher than costs of doctor's office/clinic treatment for comparable diagnoses. The costs for cases treated in the ED and released range from $157 for lead poisoning to $7,951 for liver injury. Other high-cost diagnoses include heart, lung, and other internal organ injuries, and traumatic amputation of the arm (a rare diagnosis in the non-admitted population).

Short-term costs per doctor's office or clinic case range from $55 for some poisonings to $3,789 for traumatic amputation of the leg. Other high-cost diagnoses include traumatic amputation of the arm, knee dislocation, liver injury, and neck/trunk fractures. Traumatic amputations and such, however, rarely are treated outside of hospital emergency or inpatient departments.

Example. Ambulance, prescription, and ancillary costs average $11 for ED-treated scapula/clavicle cases, yielding short-term costs of $489 per case ($478 + $11). Doctor's offices cases in the NMES data incurred no costs in these categories, so the short-term cost averages $677.

Estimate Lifetime Costs From Short-Term Costs. To estimate lifetime costs from the short-term costs, we divided the short-term costs by the DCI percentage of costs incurred after the acute care phase. Pindus et al. (1992) provides those percentages for non-admitted victims by diagnosis.

Example. DCI data show short-term costs are 85.29% of the total medical costs of a non-admitted fractured scapula. Dividing $489 by 85.29%, we estimate medical costs for a fractured scapula victim who is treated in the ED and released total $573. Similarly, costs average $793 for a victim treated only in a doctor's office or clinic.

Include Claims Processing Costs. To estimate claims processing costs for non-admitted NEISS cases, we multiplied the NHAMCS distributions of payers for non-admitted, non-motor-vehicle, ED-treated injury survivors times the claims processing cost percentages in Table 8. This procedure yielded an estimated average injury claims processing expense of 6.74% for injury survivors treated in the ED and released. A similar analysis of NAMCS data yielded an injury claims processing expense of 7.28% for non-admitted injury survivors treated only in non-ED settings. Multiplying the appropriate percentage times estimated lifetime medical costs (excluding nursing home costs) yields estimated claims processing costs.

Example. For an ED-treated-and-released fractured scapula, NHAMCS suggests claims processing costs will average 6.74% of total medical payments. Multiplying 6.74% by $573, estimated claims processing costs are $39. Total estimated health care costs for the fracture equal $612 ($573 + $39). NAMCS suggests claims processing costs for the fracture treated in the doctor's office will average 7.28% or $58. Total costs equal $851 ($793 + $58).

Summary of Medical Costs per Case by NEISS Diagnosis Category. Table 9 summarizes lifetime medical cost per non-admitted survivor of a consumer product injury by place of treatment. Medical costs are higher for non-admitted victims treated in the ED than just a doctor's office or clinic with the following exceptions: by nature, fractures, dislocations, nerve injuries, and internal injuries; by body part, shoulder and head injuries. In terms of NEISS nature of injury codes, amputations, dislocations, fractures, dental injuries, internal injuries and electric shock are most costly. Dermatitis, hematoma, and selected burns are least costly. Treatment of head, neck, and trunk injuries is most costly. Eye, hand, foot, and toe injuries are least costly to treat.

Figure 2. Steps to Build Medical Costs for Hospital-Admitted Cases

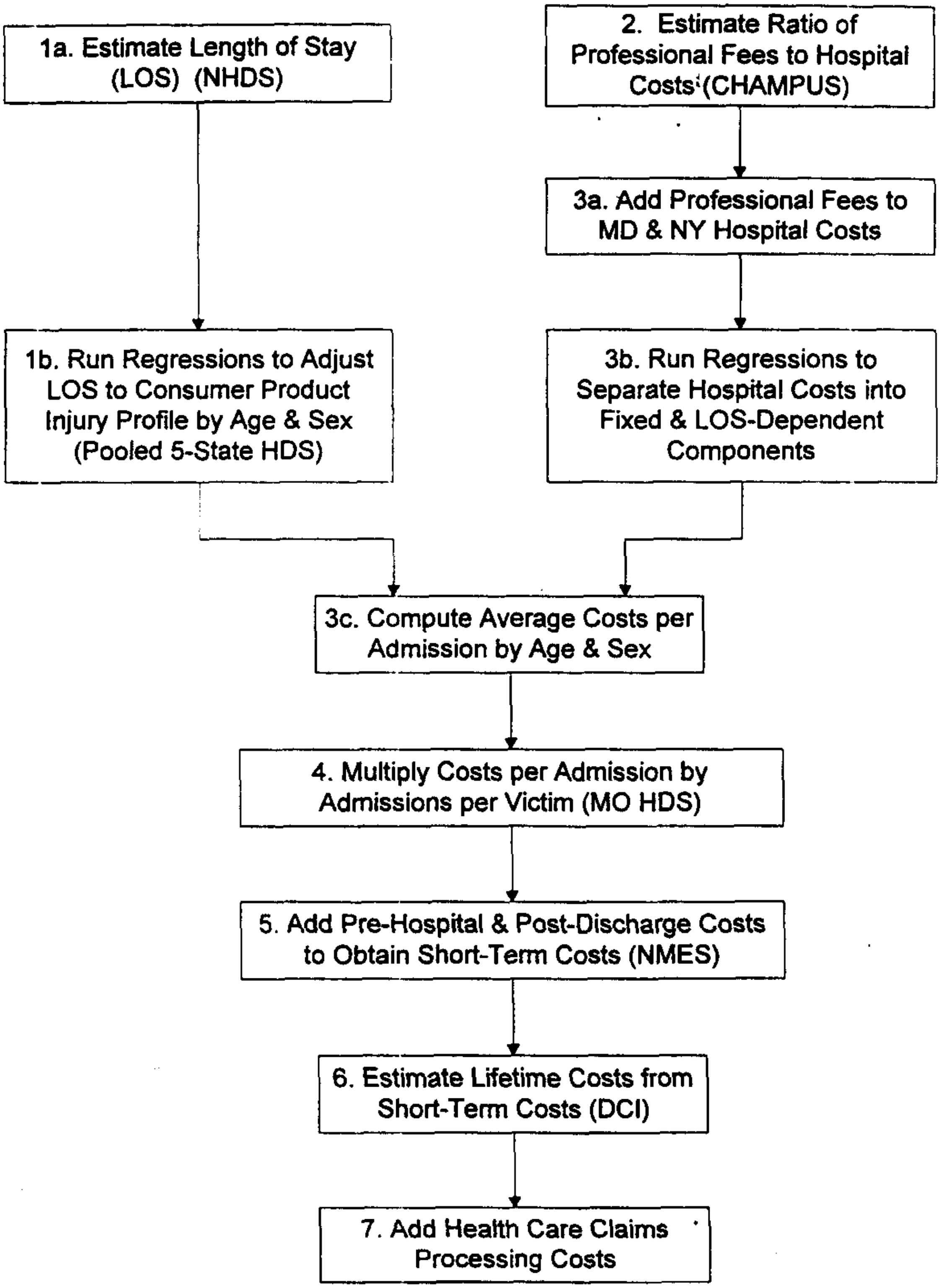

Figure 3. Injury Cost Model Medical Cost Equations

HOSPITAL-ADMITTED

Denote the medical cost per admitted case with diagnosis i as MH_i.

$$MH_i = \{(1 + c_i) \times [(1 + a) \times (1 + e_i) \times H_i] / s_i\} + N_i$$

where,

c_i =	health insurance claims processing cost factor
a =	short-term ancillary and post-discharge medical cost factor (follow-up physician visits, prescriptions, medical equipment, physical therapy, home health, etc.)
e_i =	readmission factor
H_i =	total cost of hospital visit, including professional fees
s_i =	share of medical costs incurred in short term (used to include lifetime follow-up costs)
N_i =	nursing home cost for catastrophic injuries

In this equation, i denotes either data specific to diagnosis i or to a diagnosis group that includes diagnosis i. H_i is a computed variable.

$$H_i = C_{f,i} + (d_i \times C_{v,i})$$

where,

$C_{f,i}$ =	fixed cost of hospital visit (including professional fees)
$C_{v,i}$ =	variable cost of hospital visit (including professional fees)
d_i =	length of stay in hospital (by sex and age group)

NON-ADMITTED

Denote the medical cost per non-admitted case with diagnosis i as $MN_{i,t}$, where t is an index variable indicating whether the case was treated in the ED and/or ambulatory surgery center (e) or only treated in other non-admitted settings (d).

$$MN_{i,t} = (1 + c_i) \times [(M_{i,t} \times v_{i,t}) + A_i] / s_i$$

where,

c_i =	health insurance claims processing cost factor
$M_{i,t}$ =	medical payments per visit (t = e, d)
$v_{i,t}$ =	acute care visits per case (t = e, d)
A_i =	other ancillary medical costs
s_i =	share of medical costs incurred in short term (used to include lifetime follow-up costs)

Table 7. Ambulance, Prescription, Ancillary, and Medical Follow-Up Expenses for Hospital-Admitted Injuries, and Their Relation to Inpatient Expenses

	Mean Cost	Number of Uses	Mean Uses per Case	Mean Cost per Case
Ambulance	$ 177	104	0.26	$ 46
Prescription	83	202	0.51	42
Other Medical	210	72	0.18	38
Home Health Care	2,863	41	0.10	296
Emergency Dept	248	55	0.14	34
Outpatient Dept	336	23	0.06	19
Doctor/Clinic	69	2194	5.53	381
Total Ancillary				**$857**
Hospital Inpatient	$7,258	397	1.00	$7,258
Ratio Ancillary/Inpatient				0.118

Source: 1987 National Medical Expenditure Survey
Note: Mean cost per case was computed before rounding.

Table 8. Health Care Claims Processing Expenses As a Percentage of Claims Costs by Payer

Private/Commercial Insurance	8.4%
Worker's Compensation	13.0%
Medicare	3.2%
Medicaid	6.6%
Other Government Payment	6.6%
Self-Pay	0.0%
Not Stated	0.0%
No Charge	0.0%
Other	12.5%

Source: Miller (1993).

Table 9. Lifetime Medical Costs per Survivor of Consumer-Product Injury, by Place of Treatment and Nature of Injury or Body Part Injured, Including Health Insurance Claims Processing Costs (in 1995 dollars)

NEISS Injury Diagnosis	Non-Admitted Doctor or Clinic	Non-Admitted Emergency Department	Hospital-Admitted
41 Ingested Foreign Object	331	500	6263
42 Aspirated Foreign Object	610	890	245226
46 Burns, electrical	340	520	18756
47 Burns, not specified	385	652	26016
48 Burns, scald	426	720	32139
49 Burns, chemical	254	505	26124
50 Amputation	1176	2497	13092
51 Burns, thermal	356	578	30844
52 Concussions	588	1473	5317
53 Contusions, Abrasions	320	593	16066
54 Crushing	590	651	21930
55 Dislocation	1586	1055	19396
56 Foreign Body	373	697	9546
57 Fracture	1277	1137	19594
58 Hematoma	352	458	11868
59 Laceration	493	897	13237
60 Dental Injury	1155	1798	11633
61 Nerve Damage	5231	4118	475839
62 Internal Organ Injury	4305	2085	160293
63 Puncture	304	718	11012
64 Strain or Sprain	337	500	13971
65 Anoxia	412	536	183658
66 Hemorrhage	603	1625	22153
67 Electric Shock	399	519	3414
68 Poisoning	241	729	8598
69 Submersion	412	536	32776
70 Not Stated	941	1522	24999
71 Other	903	1478	25970
72 Avulsion	364	796	11367
73 Burns, radiation	220	474	23716
74 Dermatitis, Conjunctivitis	123	225	15446
AVERAGE	634	825	28728

NEISS Body Part	Non-Admitted Doctor or Clinic	Non-Admitted Emergency Department	Hospital-Admitted
00 Internal	340	514	21885
30 Shoulder	747	693	21895
31 Upper Trunk	1188	1289	15825
32 Elbow	601	780	12009
33 Lower Arm	754	1091	13485
34 Wrist	539	696	44349
35 Knee	574	628	16789
36 Lower Leg	575	744	19270
37 Ankle	543	732	13263
38 Pubic Region	463	979	13570
75 Head	1399	1163	80995
76 Face	561	845	13712
77 Eyeball	235	497	22147
79 Lower Trunk	722	1115	19585
80 Upper Arm	852	951	19507
81 Upper Leg	454	692	28540
82 Hand	427	572	11711
83 Foot	320	559	18202
84 25-50% of Body	468	781	38753
85 All Parts of Body	404	836	48578
87 Not Stated	825	1393	12818
88 Mouth	853	1391	11314
89 Neck	638	1112	39745
92 Finger	424	712	10418
93 Toe	265	496	9555
94 Ear	536	856	12527
TOTAL	634	825	28728

7. WORK LOSS ESTIMATION

The work loss component of the revised ICM comprises four categories of work losses:

- Short-term work losses of victims (VS) are the losses resulting from the victim's physical inability to work while recovering from an injury.
- Long-term work losses of victims (VL) are the losses associated with permanent disability that remains after the injury victim has recovered to the maximum extent possible.
- Work loss of family and friends (FF) includes the time family and friends spend transporting, visiting, and caring for the victim.
- Employer costs (EM) represent the productivity that employers lose when employees are injured. The losses are varied. Notably, (1) co-workers spend time talking about the injury instead of producing, (2) supervisors spend time modifying work schedules, and hiring and training temporary or permanent replacements for injured employees, and (3) replacement staff often are inefficient until they get experience and training.

Each of the first three categories of work loss includes diversions from both wage work and household work. Although school work also is lost, from a lifetime perspective, the value of school is largely to improve the student's expected lifetime earnings. To avoid double-counting earnings loss, no additional value is attached to long-term school loss from permanently disabling injury. From a short-term perspective, the school system is carefully organized so that brief absences affect performance negligibly. For this reason, the revised ICM does not explicitly value short-term school losses. Instead, for children 14 and under (those in elementary and middle school), the value of work lost by an injured student's caregivers, included in the family and friends component, is assumed to include the value of any necessary tutoring. The sections that follow describe the details for estimating each category of work loss. Figure 4 summarizes the formulas used in the calculations.

Short-Term Work Losses of Victims (VS)

The value of short-term work loss equals the product of three factors:

- The probability of work loss.
- The days lost if a work loss occurs.
- The average value of a day's work (including fringe benefits and household production).

This section describes how we estimated work-loss probabilities and the duration of work loss for wage and household work. Then it describes how the losses are valued. It also continues the example from the medical cost chapter, providing loss estimates for a 40-year-old woman with a fractured shoulder,[29] whether hospital-admitted or non-admitted.

Probability of Short-Term Work Loss (Wage and Household). All hospital-admitted injuries obviously cause some wage and/or household work loss. We used 1987–1992 NHIS data to estimate the probability of losing work for medically treated, non-admitted injury victims. To achieve adequate sample size, we grouped ICD-9 diagnoses for analysis. For each of 26 diagnosis groupings, we estimated regression-based probabilities that injury of an employed person would result in at least one lost day of wage work.[30] The estimation procedure tailored the work-loss probabilities to consumer product injury by excluding motor vehicle cases and controlling for occupational injury origin. It also differentiated the probabilities by age group and sex. The probabilities were higher in the 18–34 age group than in other age groups, but did not differ significantly by sex.

In the regressions, NHIS work-loss probabilities by diagnosis group did not differ significantly for non-admitted injuries by highest level where treated (emergency departments versus other treatment settings). Therefore, we apply the same short-term work-loss probabilities to all medically treated non-admitted injuries, without regard to where they were treated. All injuries that prevent someone from working for pay presumably also force them to lose household work. Table 10 shows the mean work-loss probabilities for medically treated, non-admitted injury survivors. They range from 61% for back sprain, and 50% for trunk fractures, lower limb fractures, and knee/leg sprains to less than 10% for foreign bodies.

Example. The probability of losing work after fracturing a shoulder is 100% for admitted cases and 36.7% for non-admitted cases.

Duration of Short-Term Wage Work Loss. NHIS is not a good source for duration of work loss given that a loss occurs. It collects work loss only for the two weeks preceding the

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[29] Medical costs in the previous chapter were calculated for ICD-9 diagnoses, whereas the work-loss costs in this chapter are calculated for NEISS diagnoses. NEISS diagnosis 5730, fracture of shoulder, is less specific than ICD-9 diagnosis 811, fracture of scapula.

[30] We ran logistic regressions on unweighted NHIS data. The regressions estimated the probability of work loss as a function of victim sex and age group, whether the injury was occupational, whether treated in the ED, and the NHIS sampling stratification variables (region of the country, level of urbanization, and whether the locality was oversampled for blacks). Where appropriate, we also included dummy variables for body region injured and/or nature of injury. We evaluated the regression equations at the mean values for the stratifiers and with the occupational variable set to 0 to remove the influence of occupational injuries.

interview. Annual loss could be computed if we assume injury frequency is uniform across a year, but the NHIS sample size is small enough to discourage this computation.

To estimate work days lost per injury with work loss, we analyzed 1993 BLS Annual Survey of Occupational Illness and Injury data. We had to work around two limitations of this data set. First, the survey only collects days lost during the calendar year. That means the data understate losses for *open cases* -- injuries that occur near the end of the calendar year and those that result in especially lengthy work losses. To estimate mean work-loss duration by diagnosis, age group, and sex, we inferred the duration of these open cases. A second problem with the survey is that it does not indicate whether the victim was hospitalized. However, we were able to segment the mean work loss by admission status using a ratio of work loss for admitted to non-admitted victims from NHTSA data.

Estimating the duration of the open cases was statistically challenging. By applying DCI probabilities of permanent total disability by diagnosis, we randomly excluded some of the workers who had not yet returned to work in order to simulate those who never would return. For the remaining workers, we then estimated when they would return to work. The estimation used sophisticated non-linear regression models called duration models. The duration models were based on the Weibull distribution rather than the more familiar normal distribution. Weibull distributions typically are used to model how long a condition persists (for example, how long someone stays in the hospital or the expected time before a pipe fails). A problem can arise with these models if the victims in the Annual Survey differ in demographic or job characteristics that the survey does not record and that affect return to work. To handle this problem, the models include an adjustment called a heterogeneity correction made with another non-normal distribution, the Gamma distribution. Separate models estimated losses for detailed diagnoses in 13 diagnosis groups. The models were applied to estimate the duration of open cases.[31] Using all the cases, we then computed mean losses by detailed diagnosis.

The models also provided age and sex adjustment factors by diagnosis to account for demographic variation. Each adjustment factor is stated as a percentage above or below the mean work loss duration for the diagnosis. Adjustments for age and sex are given separately but are cumulative with each other.

The BLS survey data do not provide a basis for differentiating work-loss duration by admission status. To make this differentiation, the ICM uses information collected in 1982–1985 by the National Highway Traffic Safety Administration's National Accident Sampling System (NASS) for a nationally representative sample of highway crash victims.

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[31] With non-linear regressions, estimating the value of an open case requires numerical integration of a non-linear equation. Occasionally the iteratively estimated non-linear model with the heterogeneity correction would not converge, forcing us to use a model without this correction.

Analyzing the NASS data on victims who lost work reveals that work loss duration is 3.0 times as long for hospital-admitted victims as for non-admitted victims. This ratio holds when the injuries are grouped by severity (rated on a 5-point threat-to-life scale) or by body region. Because the NASS ratio is robust with respect to severity, we are confident of its applicability to consumer product injuries, despite their tendency to be less severe than highway injuries. We used the NASS ratio to segment the mean work loss estimates by admission status.

To estimate the duration of wage work loss by admission status[32], we start with the BLS-based estimate of mean work loss duration (T^*) for all medically treated injury survivors with work loss, whether hospital-admitted (h) or non-admitted (n):

$$T^* = \{[q \times T^*_h] + [(1 - q) \times p \times T^*_n]\} / r$$

where

T^*	= mean wage work loss duration for all survivors with work loss
T^*_h	= wage work loss duration for hospital-admitted victims
T^*_n	= wage work loss duration for non-admitted victims with work loss
p	= probability non-admitted victim has some work loss
q	= probability victim is hospital-admitted
r	= proportion of *all* victims with work loss = $q + [(1 - q) \times p]$

Applying the NASS ratio of work loss duration for hospital-admitted versus non-admitted victims, $T^*_h = 3 \times T^*_n$. Substituting for T^*_h in the equation above and solving for T^*_n:

$$T^* = \{[(3 \times q) + (1 - q) \times p] \times T^*_n\} / r$$
$$T^*_n = (r \times T^*) / \{(3 \times q) + [(1 - q) \times p]\}$$

Tables 10 and 11 show the mean values of p and T^*, respectively, by diagnosis group. We estimate q using NHDS counts of hospital-admitted survivors and NHIS counts of medically treated, non-admitted survivors.

A caveat about the BLS data is that the existence of Workers' Compensation creates some modest incentive to malinger in returning to work (see e.g., Butler and Worrall 1985, Currington 1994, Johnson and Ondrich 1990, Krueger 1990, Johnson, Butler, and Baldwin 1995). This incentive may not exist for injuries outside the workplace. We were unable to adjust the estimated work-loss durations to account for this problem.

Table 11 summarizes how the duration of short-term work loss varies, by 13 broad BLS diagnosis groups, for injury victims who lose work. Work losses average more than 40

[32] Although the revised ICM specifies work losses for each relevant combination of diagnosis group, sex, and age group, the discussion omits the corresponding subscripts in the interest of simplification.

days for diagnosis groups that include amputations, internal organ injuries, nerve damage, fractures, dislocations, and crushing injuries. Poisonings and environmental injuries like frostbite and heat stroke involve the shortest work losses, averaging 7 to 8 days.

The left panel in Table 12 summarizes estimated probabilities of work loss for non-admitted injuries (p) and mean work-loss durations for lost-work injuries (T*) by sex and NEISS nature of injury diagnosis.[33] Burns and sprains/strains have the highest probabilities of non-admitted work loss. Non-admitted ingested/aspirated foreign object and anoxia injury victims have the lowest probabilities of work loss, but these injuries cause some of the longest work losses when an absence occurs. Other injuries associated with mean work losses exceeding 35 days include amputations, dislocations, fractures, and nerve damage. Chemical burn, foreign body, puncture, and submersion victims have the shortest average work loss -- less than 10 days.

The right panel in Table 12 summarizes the same work-loss data by NEISS body part. Knee, ankle, lower trunk/back, and neck injury victims have the highest probabilities of work loss from non-admitted injuries; ear and internal injury victims have the lowest probabilities. Average work-loss durations exceed 35 days for shoulder, upper arm, internal, and lower trunk/back injury victims with work loss, but are less than 10 days for face, eye, and ear injury victims with work loss.

Example. Our analysis of the BLS annual survey data (summarized in Tables 11 and 12) reveals that the mean duration of wage-work loss from a lost-work shoulder fracture is 61.8 days. For this injury, the work-loss duration does not vary by sex, but for someone of age 35–54 it is 6% higher than the overall mean. Therefore, the mean work-loss duration (T*) for a woman age 40 is 65.5 days.

Of medically treated shoulder fractures, 3.65% are hospital-admitted (q=.0365). Recall that 36.7% of non-admitted cases result in work loss (p=.367). That means the percentage of **all** medically treated shoulder fracture victims who incur work losses (r) is

$$.0365 + (.9635 \times .367) = .390$$

Estimated mean duration of work loss per non-admitted victim age 35–54 with work loss (T^*_n) is

$$(.390 \times 65.5 \text{ days}) / [(3 \times .0365) + (.9635 \times .367)] = 55.2 \text{ days}$$

The average work loss duration for admitted cases (T^*_h) is 3 times as long, or 165.5 days.

<u>Duration of Short-Term Household Work Loss</u>. We estimated the number of days of lost household work (T') from the number of days with lost wage work (T*). To do so, we applied the procedure in Miller (1993) and Miller, Cohen, and Wiersema (1994). The procedure has two steps. First, lost wage-work days are multiplied by 365/243, since people do

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[33] Detailed estimates by NEISS nature of injury and body part diagnosis are in the separately bound appendices.

household work daily, 365 days a year, but typically do wage work on only 243 days a year.[34] Second, the product is multiplied by 0.9, because Waller et al. (1990) and Marquis (1992) find people cannot do housework on 90% of the days when injury would have prevented them from doing wage work. This procedure assumes that injuries with the same diagnosis and highest treatment level are equally severe for employed victims and other victims.

Example. If the woman's fractured shoulder results in work loss, it is expected to cause 223.7 days of household work loss (165.5 × .9 × 365/243) if hospital-admitted (T'_h) and 74.6 days of household work loss (55.2 × .9 × 365/243) if non-admitted (T'_n).

Value per Day of Work Lost. The duration models assess work loss in days. Wage data, however, typically are collected on an hourly basis. To cost a day of work loss, therefore, requires information on hours worked per day.

Conventionally, a day of wage work is valued as eight hours of work. The number of hours in a day of lost housework is less obvious. After evaluating available alternatives, Douglass et al. (1990) recommend using a regression model from Peskin (1984) to estimate the hours of household services performed per day by sex and age group. The model takes account of household demographic structure (e.g., marital status, family size, age of youngest child, parental education, and employment status). We applied the regression model to 1993–1994 Census Bureau data. Peskin developed her model for a data set of working-age people. Therefore, we used another source, the 1985 Panel Study of Income Dynamics, to estimate household work losses per day for the elderly (Miller and Jensen 1997).

Conceptually, the value of an hour of wage work equals the hourly wage rate plus fringe benefits. An hour of household work was valued using a method called the specialist cost approach (see Douglass et al. 1990 for a review). This approach starts by cataloguing the average hours per day the person spends on different categories of household tasks (for example, cooking, cleaning, child care, financial management, repairs and maintenance, and gardening). The time spent is valued at the average hourly wage of specialists in the relevant fields (a cook, a house-cleaner, a day care worker, a bookkeeper, etc.). We were able to differentiate the mix of tasks performed by sex, but not by age, because the sample size was small. Standard criticisms of this approach are that (1) a professional might perform the tasks at a different pace, (2) people may view portions of some tasks as leisure rather than work (e.g., gardening, child care), and (3) child supervision goes on as a background task 24 hours daily; the specialist cost approach only values child-care hours when this care is the primary activity.

[34] The 243-day figure excludes holidays and leave -- days for which injured workers lose neither work nor income.

We valued wage work losses with BLS data on average annual earnings by age group and sex in 1992 (based on a 2,080-hour work year) multiplied times probabilities of being in the labor force and employed by age group and sex. We valued the household production losses with BLS data on wages by occupation in 1993. Fringe benefits are valued at 21.9% of wages according to data about wages and supplements in the National Income Accounts (Clinton 1997). Wages were converted to 1995 dollars with the Employment Cost Index (Clinton 1997).

Example. The estimated cost of short-term work loss for a 40-year-old woman with a hospital-admitted shoulder fracture will be $17,215 (165.5 days × $104.02/day) in wage work plus $7,469 (223.7 days × $33.39/day) in household work. For a non-admitted case of the same type of injury, her estimated work loss cost would be $2,107 (36.7% probability of work loss × 55.2 days × $104.02/day) in wage work and $914 (36.7% probability of work loss × 74.6 days × $33.39/day) in household work.

Long-Term Work Losses by Victims (VL)

When injury results in permanent (or "long-term") disability, the victim will lose work annually until death. The expected value of long-term work loss from an injury is the product of three factors:

- The probability of permanent disability.
- The percentage of earning power lost to the disability.
- The value of the lifetime of work the victim would have done absent the injury.

Probabilities of permanent total and permanent partial disability by diagnosis and hospital-admission status were estimated by Pindus et al. (1991). The probabilities came from 1979–1988 DCI data about permanent disability **among Workers' Compensation lost-workday claimants**. Averaged across DCI states, workers must lose at least four days of work to become claimants. For non-admitted cases, the DCI probabilities were multiplied by probabilities of losing work to injury from 1987–1992 NHIS data and probabilities of losing at least four days to a lost-work injury computed from the 1993 BLS annual survey data (net of admitted cases). Since all admitted cases presumably involve lost-workday claims, their DCI probabilities were not modified.

The DCI data lacked usable permanent disability information about poisoning (because industrial and consumer product exposures to toxics are quite different), ingested foreign objects, dermatitis, and conjunctivitis. We used the disability probabilities for internal organ injuries for poisoning and ingested foreign objects. We conservatively assumed dermatitis and conjunctivitis never resulted in permanent disability.

Total permanent disability results in 100% earnings loss. According to Berkowitz and Burton (1987), on average, partial permanent disability results in a 17% loss of earning power. We assume an equal loss in lifetime household production. While the percentage loss would obviously vary by diagnosis, data on the differences were unavailable (except for data from Berkowitz et al. [1990] about the losses associated with spinal cord injury). For the four admitted diagnoses that involved permanent custodial care (traumatic brain injury, asphyxiation, aspirated foreign object, and submersion), we assumed the total permanent disability probabilities at least equalled the institutionalization probabilities.

The accepted way to value lifetime work is to multiply the average sex-specific value of work at a given age by the probability of surviving to that age. The future work is discounted to present value (the amount that would have to be invested today to pay someone to do this work in the future). We used NPSRI's proprietary linked FORTRAN and LOTUS modelling system to compute the present value of lifetime wage and household work losses. The system includes a standard age-earnings model as described in Rice et al. (1989) and Miller et al. (1996).

The NPSRI model inputs include 1992–1993 probabilities of survival, earnings if employed, 20-year average probabilities of labor force participation and employment given participation, and annual household production (365 times the daily household production estimates by age group and sex used in estimating short-term wage loss, as described above). The 20-year averages are superior to a single year of data because they adjust out the effects of the business cycle.[35] All values, including the estimated value of lifetime work, are broken down by sex and by age group (in 5-year increments, up to 85 and over). The revised ICM computes lifetime earnings losses at a 2.5% real discount rate.

Table 13 shows the present value of lifetime wage work and household work by age group and sex. (For reference, Table 13 also shows the **annual** value of household work.) The expected value of lifetime work is higher for younger people because they have the most productive years remaining. In present value terms, young workers have higher lifetime work values than children who have not started working. Although their total expected work is equal, the children's work is all in the future and must be discounted. Predictably, men have higher average wage work losses but lower household work losses than women.

Example. A hospital-admitted fractured shoulder victim has a 1.25% probability of total permanent disability ($d_{t,h}$) and a 23.82% probability of partial permanent disability ($d_{p,h}$). The corresponding probabilities for a non-admitted victim are 0.00% ($d_{p,n}$) and 2.33% ($d_{p,n}$). The probability that a non-admitted case results in work loss (p) is 36.7% and the probability that such a work loss lasts at least four days is 77.8%. From Table 13, the present value of expected lifetime work (K) for a 40-year-old female is \$662,851 in 1994 dollars, or \$680,026

[35] They do, however, ignore any temporal trends independent of the business cycle.

inflated to 1995 dollars. The value of expected long-term work loss for an admitted injury (VL_h) is

$$VL_h = K \times [d_{t,h} + (.17 \times d_{p,h})]$$
$$= \$680{,}026 \times [(.0125 + (.17 \times .2382)] = \$36{,}037$$

For a non-admitted injury, the losses would amount to

$$VL_n = K \times [d_{t,n} + (.17 \times d_{p,n})] \times p \times f$$
$$= \$680{,}026 \times [(.0000 + (.17 \times .0233)] \times .367 \times .778 = \$770$$

Total Cost of Victim Work Loss

Table 14 summarizes the total expected cost of victims' work losses, including both short-term and long-term losses of both wage work and household work, averaged across all demographic groups. The left portion of the table summarizes costs per victim by NEISS nature of injury and admission status. Hospital-admitted survivors generally have higher work losses than non-admitted survivors. Among admitted survivors, the highest costs are for submersion victims, followed by victims of amputations, anoxia, and nerve damage. The lowest costs are for poisoning, dermatitis, and conjunctivitis survivors.[36]

The right portion of Table 14 presents the value of expected total victim work losses by body part injured. Extremity injuries generally cause the greatest work losses among admitted victims, with toe injuries serious enough to require hospital admission imposing especially large losses. Upper extremity injury victims experience the largest average work loss per non-admitted case.

Work Loss of Family and Friends

To value visitor and caregiver work loss, we started with the value of daily work (wages plus fringe benefits plus household work) by age group and sex (described earlier in this chapter, in the section on short-term work losses). Using the 1995–1996 NEISS age and sex distribution for ED-treated consumer-product-injury victims ages 20–64, we computed the average daily value of wage and household work. The estimated loss for each day of lost work is \$98. This loss is the average across weekdays and weekends and across labor force participants and non-participants. It includes \$76 in lost wages and fringe benefits and \$22 in lost household production. It equates to roughly \$6 per waking hour.

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[36] The costs for these diagnosis categories are low, in part, because we were unable to estimate their associated permanent disability probabilities very well.

To represent the time people lose while transporting and visiting injury victims, we used the time-loss estimates in the original injury cost model. Those estimates assume that initial injury treatment causes family and friends to spend an average of two person-hours transporting the victim and waiting while the victim is treated (Technology and Economics 1980). In addition, for admitted cases the model assumes three hours of family travel and visiting time per bed day. We assume an admitted victim spends one post-discharge day in bed for every day spent in the hospital, so bed days are twice the length of stay in the hospital. For non-admitted cases, we assume two hours for transportation but nothing for visitor time because we do not believe visitor costs typically are associated with non-admitted cases. Therefore, transportation time costs $12 per case (2 hours × $6/hour). Visitor time costs for admitted cases are $18 per bed day (3 hours × $6/hour).

In addition to visitor and transportation costs, caregiver costs are associated with bed days at home. The model estimates caregiver costs for children but not for adults. When a child cannot attend school or day care because of an injury, a caregiver almost always is needed. By diagnosis and admission status, the model assumes that an injured child requires a caregiver for the same number of days an employed adult victim of a comparable injury would lose from wage or household work. This caregiver time plus the child's school-work losses are valued, somewhat arbitrarily, at the $98 average value of a lost work day.

Example. A hospital-admitted female shoulder-fracture victim age 35-54 averages 3.36 days per admission and 1.072 lifetime admissions for this injury. Thus each such case results in an average of 3.6 hospital days and an additional 3.6 post-discharge bed days, for a total of 7.2 bed days. Visitor costs are estimated at $142 ($12 + $18 × 7.2). For a non-admitted case, family cost includes only transportation time at $12.

Employer Costs (EM)

We estimated employers' productivity losses resulting from non-occupational employee injury by refining the assumption-driven methods in Miller and Galbraith (1995). This cost factor appears to be modest in size. Nevertheless, it may warrant further study.

Employers incur a variety of costs resulting from non-occupational injuries to employees. The original model did not separate these costs. This section discusses how the revised ICM estimates these costs.

Employers lose productivity whenever an employee works at less than usual capacity or is diverted to less demanding tasks (Miller 1997a). Uninjured co-workers also may lose productivity (Miller and Rossman 1990, NHTSA 1984). During an employee's temporary absence, colleagues may assume the additional workload. As a result the employer may have to pay overtime. In other cases, work may be rescheduled, awaiting the injured employee's return. If replacements must be hired, the injury imposes costs for training temporary or permanent staff. Replacements for injured employees may cost further productivity because they are less skilled or have a start-up period. Some employees -- an award-winning chef, for example -- have irreplaceable skills (Miller 1997a). Injuries outside of work, even injuries to family members, distract victims and co-workers, prompting them to talk and worry about the injury victim rather than producing. Finally, supervisors and executives lose valuable time assisting injured employees, rescheduling production, hiring temporary or permanent replacements, or providing training. Further reductions in profitability may result from interference with production, failure to fill orders on time, loss of bonuses, or payments of forfeits (Miller and Rossman, 1990).

Employer costs of injury previously have been estimated in two related journal articles, Miller and Galbraith (1995) and Miller (1997a). The thrust of these articles was to assess whether employer costs might be an important cost factor. The estimates were built from *four assumptions:*

- One-quarter of the time that other employees lose because an employee suffers a non-occupational injury is supervisory time.

- An employee's death or permanent disability costs an employer 4 months of wages plus fringe benefits. Recruitment, retraining, and lost special skills are the major components of this cost.

- A hospital-admitted injury costs one month of wages plus fringe benefits for other employees.

- Non-occupational injuries involve 3 days of productivity loss for other employees if they involve victim work loss and 1.5 days if they are medically treated but do not result in lost work.

The Miller and Galbraith (1995) assumption of 4 months (83 days) lost by supervisors and co-workers per permanently disabling injury seems reasonable, but their other estimates seem a bit high. Accordingly, we reduced the prior assumed **supervisor and co-worker time losses** for non-occupational injuries as follows:

- For hospital-admitted injury of an employed person, 10 days.

- For other injuries with wage work loss, 3 days.

- For other medically treated injury without wage work loss beyond time to seek medical treatment, .25 days (i.e., 2 hours).